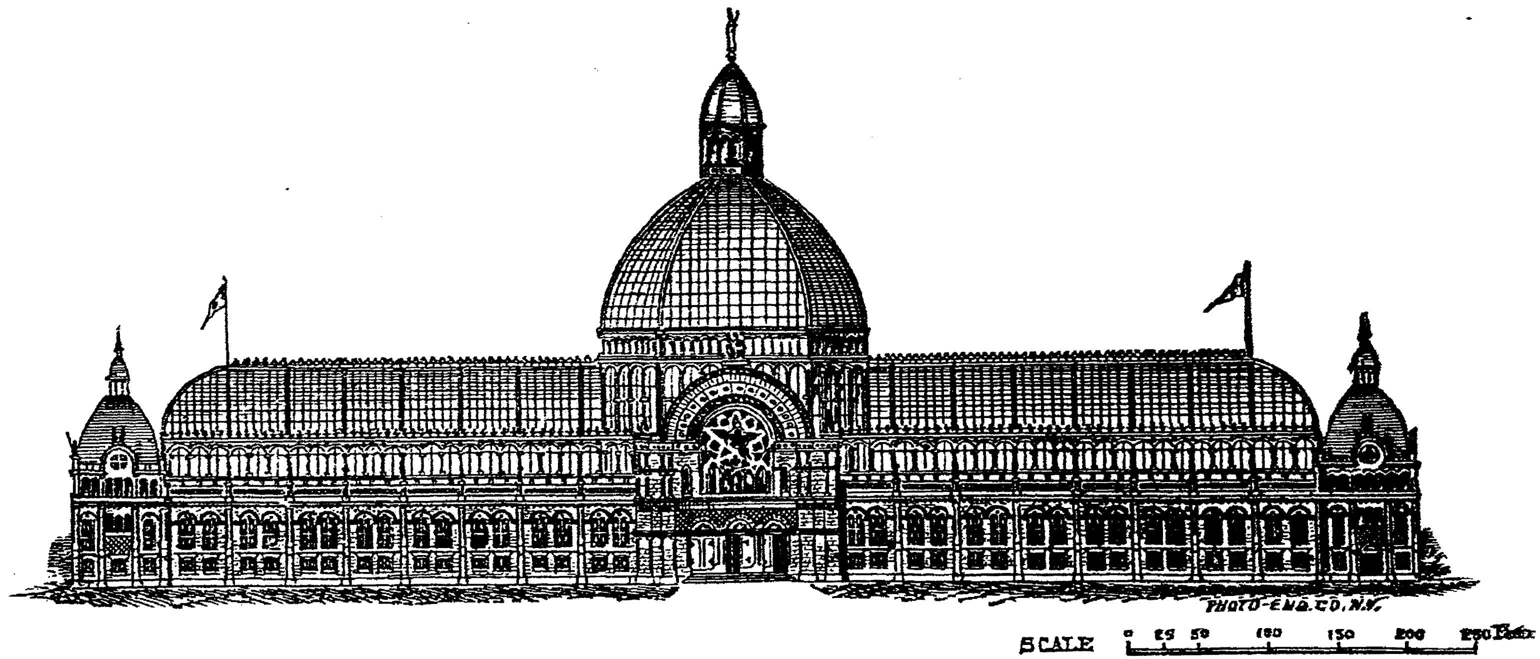
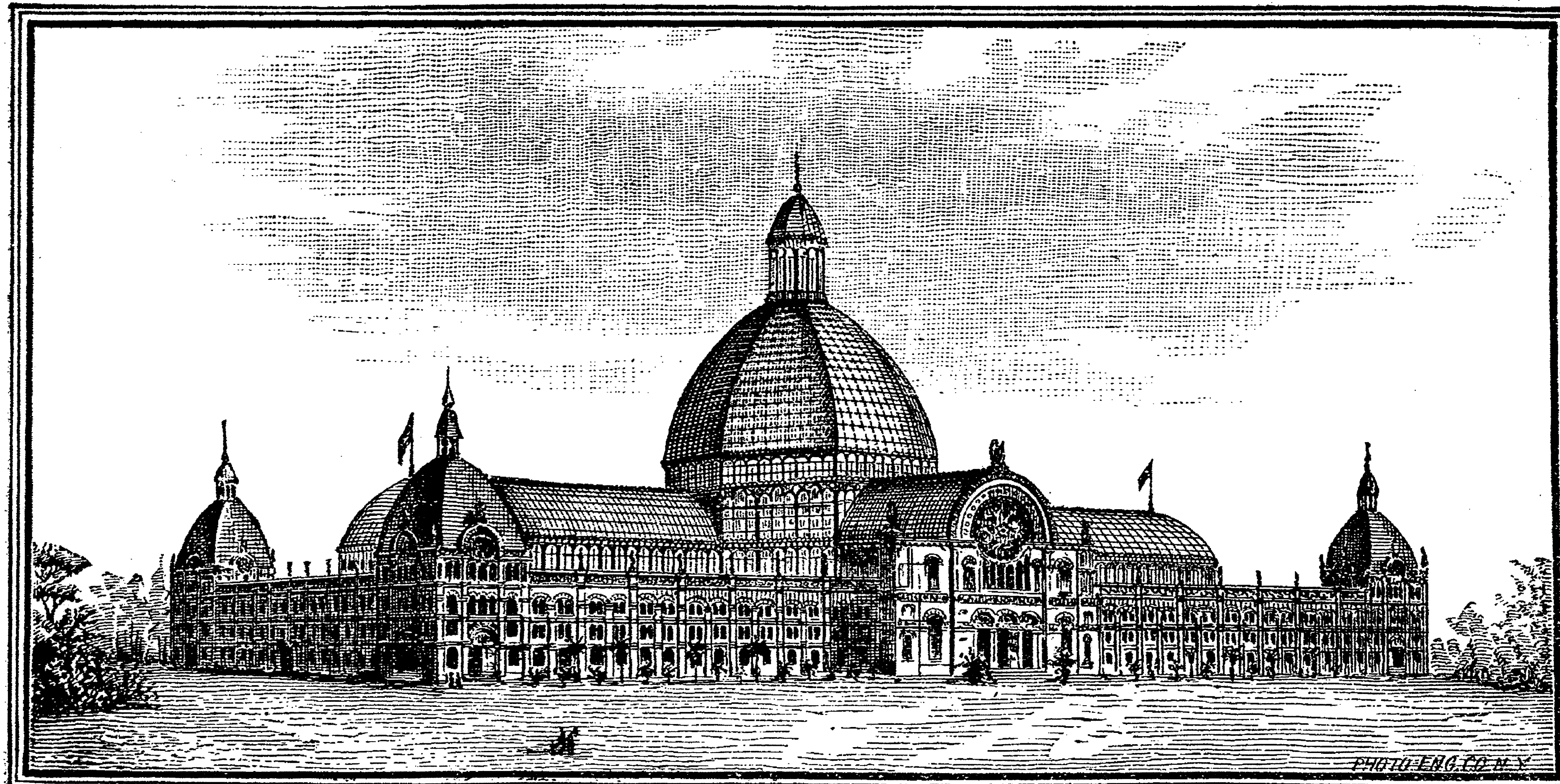
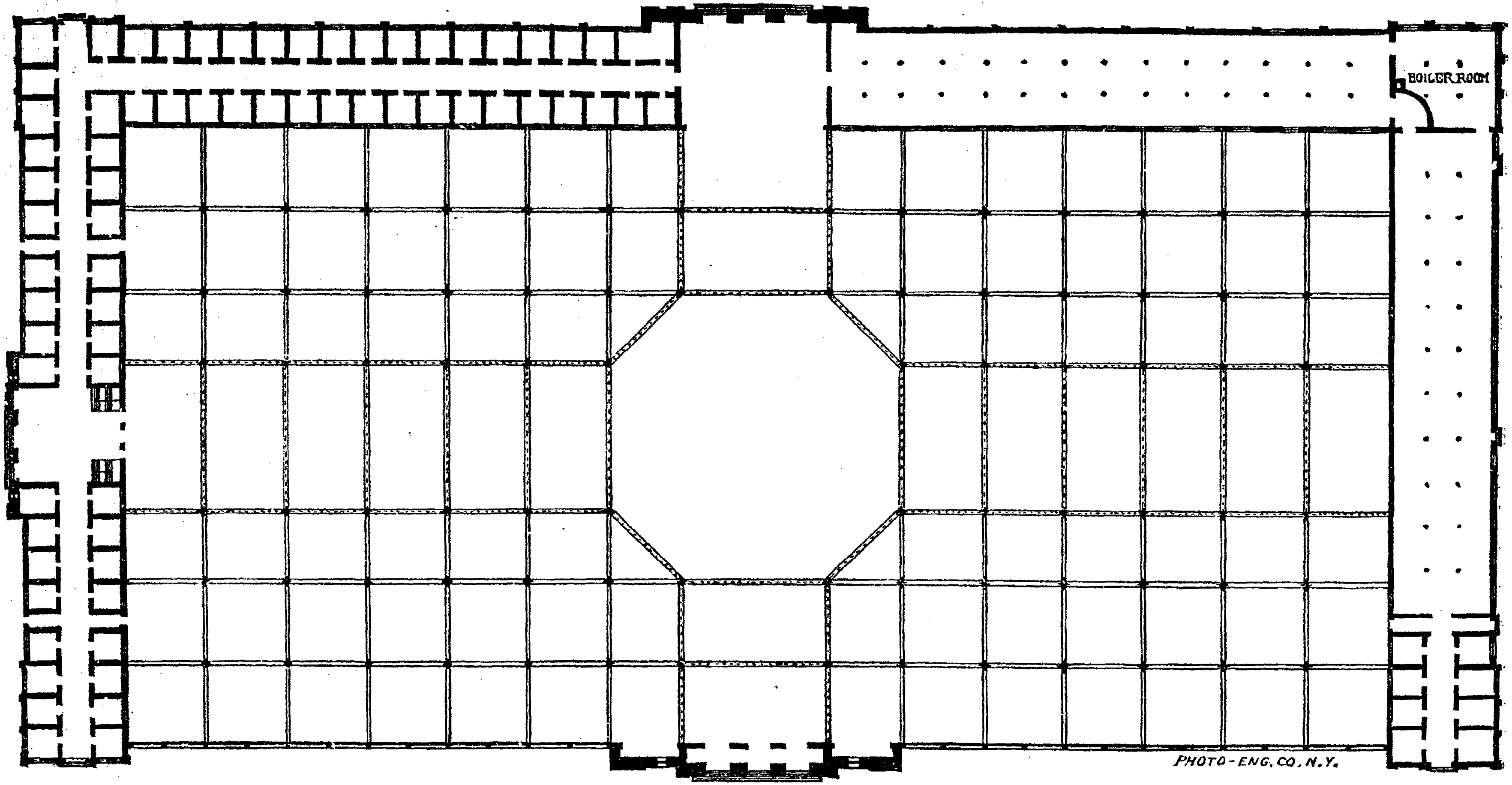


SOUTH ELEVATION of proposed BUILDING for the DEPARTMENT OF AGRICULTURE. J. RENWICK, ARCHT., N. Y.



DESIGN for the proposed BUILDING for the DEPARTMENT OF AGRICULTURE,

CITY OF WASHINGTON.



PLAN of proposed BUILDING for the DEPARTMENT OF AGRICULTURE.

J. RENWICK, ARCHT., N. Y.

ANNUAL REPORT

OF THE

COMMISSIONER OF AGRICULTURE

FOR

THE YEAR 1880.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1881.

JOINT RESOLUTION relative to printing the Agricultural Report for the year eighteen hundred and eighty.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That there be printed three hundred thousand copies of the Annual Report of the Commissioner of Agriculture for the year eighteen hundred and eighty; two hundred and fourteen thousand copies for the use of members of the House of Representatives, fifty six thousand copies for the use of members of the Senate, and thirty thousand copies for the use of the Department of Agriculture.

Approved, March 2, 1881.

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REPORT

OF THE

COMMISSIONER OF AGRICULTURE.

To the President:

I have the honor to submit my fourth annual preliminary report, it being the nineteenth report since the organization of the department in 1862.

During the four years of your administration now drawing to a close our farmers have rejoiced in the realization of higher rewards for agricultural labor than during any other continuous four years in our history. They have been years of exceptionally good crops of all the different staples grown either for home consumption or export; and as the European nations to whom we look for a market have during the same period failed, from disastrous seasons, to harvest the usual quantity of farm products, a steady demand at good prices has existed for our entire surplus of wheat, corn, cotton, meats, and dairy products, unti the aggregate annual amount exported has attained a value of more than $271,000,000 in excess of the value of similar exportations during any like number of previous years. These unprecedented crops, the bountiful gift of an All-Wise Providence that governs in the affairs of men, have afforded constant and profitable occupation not only to the farmers but to the manufacturing and commercial classes, as well as to the great transportation companies whose trains and fleets have had uninterrupted and remunerative employment, notwithstanding their own increased capacity and the ever eager competition of new lines. Indeed there is no profession, no trade, no occupation, no man so rich and exalted nor yet so poor and unknown, but has shared in their widespread and beneficial influences.

The following tables exhibit the immense value of the most important of our agricultural products during the several years named and the value of the exportations thereof for the same period.

Value of the principal agricultural productions by calendar years.

Breadstuffs, animals, animal matter, cotton:	
1877	$1,644,820,578
1878	1,448,570,866
1879	1,919,054,397
1880 (estimated)	2,000,000,000

Value of the agricultural exports for the fiscal years ending June 30, 1877, 1878, 1879, 1880.

Products.	1877.	1878.	1879.	1880.
Animals and animal matter	$140, 564, 066	$145, 587, 515	$146, 641, 233	$166, 400, 428
Breadstuffs, &c	118, 126, 940	181, 811, 794	210, 391, 066	288, 050, 201
Cotton, &c	183, 253, 248	191, 470, 144	173, 158, 200	221, 517, 323
Wood, &c	23, 422, 966	21, 747, 117	20, 122, 967	22, 000, 000
Miscellaneous	58, 652, 719	52, 245, 306	53, 843, 026	49, 000, 000
Total agricultural exports	524, 019, 939	592, 861, 876	604, 156, 492	746, 967, 952
Total exports	689, 167, 390	722, 811, 815	717, 093, 777	823, 946, 353
Per cent. of agricultural matter	76	82	84	90

This shows an unusually prosperous condition, and that, to-day, ours is pre-eminently the agricultural country of the world. The casual reader, and the most indifferent student of statistics cannot but be struck with the large proportion that agricultural products as shown by the above table bear to the total exports of the United States; and every man of intelligence in pondering the fact must stand amazed that the agricultural interests of the country have not received more attention in State and national legislation.

DIVISION OF CHEMISTRY.

This important division of the department is now confined to a room in the present building 20 feet square, with two basement rooms of the same size, and a small closet. It is utterly impossible, with such lack of conveniences, to promptly perform a great deal of work, any delay in which, and in publishing the facts thus only to be ascertained, is a loss to the country. The work is daily accumulating. It comes to us from every part of the United States and her Territories. Its value is almost beyond computation. The numerous experiments and analyses that have been made in this division serve to illustrate, in part, how essential to the proper working of the department, and, as a consequence, to the country, is a well-appointed laboratory.

Being the national laboratory of a great people, it should have greatly increased facilities for examining and determining the many important questions daily coming up for investigation.

The small increase in the appropriations for the laboratory has enabled this division to extend its work in various ways, but particularly and profitably in verifying the results of experiments heretofore made in the examination of the juices of different saccharine plants. Seeds of 42 supposed varieties of sorghum, bearing in most cases the name of the grower or of the locality whence obtained, were planted in a little patch of ground attached to the department, and the resulting plants subjected to daily examination and analysis from the appearance of the tassel until November 22, at which time the stalks and the ground were alike hard frozen. In these daily examinations under the immediate direction of the chief chemist, there were employed, in addition to the regular force, 11 assistants (chiefly young graduates of chemical schools),

and a very large amount of valuable work was accomplished. In all something over 3,500 analyses were made, all doubtful results being verified and corrected by repetition. This careful work served to sustain every statement heretofore made by the department in relation to these sugar-producing plants, and affords a sure basis for estimating the profit that may be derived from the manufacture of sugar from these varieties of cane, and will be of great value to all persons engaged in sugar production who may carefully study the tabular statement to appear in the forthcoming detailed report of the chemist.

Among the varieties of sorghum sent to us under their different local names many were found, when grown, to be identical. The number of distinct varieties of value for making sugar has been reduced to 25, so that we may say with certainty that we have growing in this country at least that number of separate varieties concerning which there remains only to be determined what soil and climate is best suited to any particular sort. The difference in the quality and quantity of saccharine matter in the various kinds is so slight as to be a matter of little consideration.

The variety generally known as Early Amber, but sent to us under many different names, proves to be somewhat earlier than any other and the equal of any in the richness and purity of juice, although not quite so productive as the larger and later varieties.

In this connection it may be well to refer to the experiments which have been made in the grounds of the department with machinery adapted to the manufacture of sugar in a commercial way. It was considered important to undertake the work on a scale of this magnitude in order that the large number of farmers and others who were ready to engage in the business should be satisfied as to its practicability and profitableness—that the proportion of crystalizable sugar found in laboratory experiments to be present in the stalks of sorghum and of corn (maize) could be secured without difficulty and with profit as an article of commerce. A careful estimate showed that the cheapest outfit of machinery entirely suited to this purpose would cost in the city of New York about $10,000, and that to have the cane grown wherever vacant land could by chance be rented in the vicinity of Washington, or neighboring farmers be induced to undertake an untried crop; to haul the cane long distances, and to manufacture would cost several thousand more. Accordingly an appropriation of $15,000 was asked for and was voted by the Senate, but was reduced in the House of Representatives to $6,500, and so finally passed both branches of Congress. Not only was this sum entirely inadequate to the object in view, but available so late as to render the planting of a sufficient supply of cane entirely impossible. Pending legislation, and in anticipation of more favorable action on the part of Congress, I had conferred with Messrs. Colwell Brothers, large manufacturers of sugar machinery in New York City, and had notified them that I would probably wish to purchase a

complete sugar mill (with vacuum pan and centrifugal) similar to those used on sugar plantations in Louisiana and Cuba. When the appropriation was cut down from $15,000 to $6,500 and the purchase could not be made, these public spirited gentlemen declared that the machinery should be at my service upon my own terms rather than an experiment of so much importance to the country be put over to another season. Such parts of the machinery as they had not in stock and were too busy to prepare they caused to be made in other shops, brought the whole to Washington, superintended its erection and loaned their experienced men to start and run the mill until others detailed for the purpose should become familiar with its management. With the usual delays incident to erecting and starting a new mill, and the changes in gearing found on starting to be necessary, the work of grinding, &c., which was expected to be begun September 1 was delayed until after the 1st of October. Then followed a break in the machinery which delayed operations two weeks longer, so that it may be said the work was not fairly commenced until the middle of October, fully six weeks later than it should have been.

Meanwhile the cane had been cut and drawn up to the yard, and was not improved by being piled in large ricks. From late planting (the greater part on poor land) it was far from promising to begin with, much of it being less than half an inch in diameter, and rapidly deteriorated from heating in the rick while awaiting repairs to the machinery.

Mr. Theodore Kolischer, a sugar manufacturer, who had experience in making beet sugars in Germany and cane sugars in the West Indies, was selected to treat the juice precisely as he would the juice of the tropical cane, and then to make such modifications and suggestions as the character of the juice would seem to require. His report will be appended. Mr. Kolischer hoped to build up sufficient granulation in the vacuum pan to enable him to strike directly into the centrifugal, as is usual with tropical cane; but this he did not succeed in doing. He, however, obtained some barrels of sugar from the first boiling by letting it stand for a few days and granulate in the tanks. This sugar is well crystallized and polarizes 88; is yellowish green in color and not attractive in appearance, but will command a paying price for refining. The sirup made at first was not as clear and fine in flavor as was afterwards obtained. When Mr. Kolischer's time expired there remained a sufficient quantity of cane on hand for three days' work, but cane of very inferior quality, since it had been subjected to severe frosts by which the joints had been rendered more or less acid. The experiments were continued by employés of the department who had become familiar with the machinery, and by them better results were obtained from this injured cane than from that first handled. This was chiefly due to the more careful defecation of the juice under the personal direction of Professor Collier, and it is a matter of regret that there was not a supply of cane sufficient to permit of many other experiments in the defecation,

clarification, and crystallization of the juice and sirup, important experiments which must be postponed until another season. The supply of cane exhausted, an experiment was made in reboiling the molasses which had not given evidence of granulation. Upon diluting this with water, clarifying by boiling and skimming, and further boiling in vacuo, considerable sugar was produced of excellent quality and color, as evidenced by the fact that it polarizes 99, and is valued to day by one of the leading grocers of this city at nine cents per pound. On the whole these experiments, although made under very unfavorable circumstances, have been attended with so fair a measure of success as to give assurance that, with the machinery as now in position and an adequate amount of cane, planted at the right time and cultivated in the right way, both sorghum and corn-stalks can be profitably employed in the production of sugar for market. It is to be hoped that Congress will vote the funds necessary to continue these experiments as long as they promise to be of great value to the people.

A tabular statement showing the condition of the industry among the people at large will be found appended to this report, by which it will be seen that very decided progress has been made during the past year in the direction I had the honor to propose some two years since, to-wit, the manufacture at home of all the sugar we consume, with some to spare for export. This statement and the many letters upon the subject from intelligent correspondents in every part of the country justify the belief that the crop of 1884 will terminate our dependence on foreign nations for this article of prime necessity.

In addition to the work of this division above indicated, the examination of our native grasses and forage plants from different parts of the country has been and is being carried forward and, besides, analyses—over 150 in all—are making or have been made of twenty different well known genera or species of such grasses as are now extensively grown, for the purpose of deterinining their comparative composition and nutritive value at different stages of their development.

Some idea of the value of this work, in mere dollars and cents and aside from its "consequential" benefits, may be gained from a consideration of the fact that, among individual chemists operating on their own account, the current price for a single mineral determination is about $10, and that analyses for organic constituents are even more expensive. But accepting $10 as the average value of each specific determination, the chemical work of the department from June, A. D. 1880, to January, 1881, will make the following exhibit:

150 grasses, 7 determinations each	$10,500
3,581 canes, 4 " "	143,240
Total	$153,740

BEET SUGAR.

Since the publication of the last Annual Report there has been prepared in the department a report on the "culture of the sugar beet, and

the manufacture of sugar therefrom in France and the United States." This report is intended to show the conditions favorable to the culture of the sugar beet, and the methods of planting, manuring, cultivating, harvesting, and storing the crop in France, the later improvements introduced in the methods of manufacture of sugar from the beet, and the social and fiscal relations effecting the beet sugar industry in that country. That portion relating to the manufacture is not intended to give details relative to the methods employed, but to furnish to prospective manufacturers correct notions concerning improvements in apparatus, &c., that have been made up to 1878, and estimates of the cost of requirements for a complete factory. The report is accompanied by illustrations of most of the improvements mentioned, and of the new instruments employed in cultivating the root.

In connection with this report of the experience of the French in the manipulation of this great industry, it seemed advisable to give a statement of the results of the practical experiment making at Portland, Me., in the introduction of the industry in that section.

A representative of the department was sent to make an examination and report upon it. It was found that the Maine Beet Sugar Company had erected works with all the appliances for extraction of sugar from beets, and with a capacity of 150 tons per day. They had made contracts with seventeen hundred farmers for the culture of 1,200 acres of roots. The culture was, therefore, eminently experimental, but from conversations with some of the farmers it was found that very few were able to give intelligent accounts of their operations or of the expenses attending them. The sugar company issued circulars giving minute instructions concerning the methods that should be followed in the work, and in order to determine how closely these instructions were followed, the results obtained, and the cost per acre of producing the crop, a circular of questions covering these points was mailed from the department to all persons who had grown beets for the company, whose names and addresses could be obtained. Replies to these circulars—200 of the first to 1,500 of the latter—were not as numerous as I had had a right to expect. The few received show the influence of the various soils, and the methods of culture and manuring upon the crop. If we accept the more reasonable estimates of the value of farm labor and of stable manure, it appears that the cost of producing a crop and delivering at stations within an average haul of half a mile (with the cost of stable manure and artificial fertilizers added), is about $60 per acre, and that the crops produced with the care that this expenditure demands should amount to from 15 to 23 tons, which, at the average of $5 per ton, the price paid by the company, would net to the producer $15 to $23 per acre.

The report upon the experiment in Maine is accompanied by a statement of the history of former experiments in this industry in the United States, and the encouragement and aid given for its promotion by the general and State governments.

Of the combined reports, Congress ordered the printing of 20,000 copies, which should have been printed and distributed in time to serve for the information of persons who desired to engage in the cultivation of beets and the manufacture of sugar during the past season, but which are yet in the office of the Public Printer, and a delay of a year in enterprises of public importance has been the result.

MAINE BEET SUGAR COMPANY.

The condition of the Maine Beet Sugar Company at the present time is well described in the Eastern Argus, of October 28, 1880, as follows:

The fall and winter work of the Maine Beet Sugar Company is now fairly begun, and the factory is in full operation. The factory employs in all its departments, including the storage and shoveling the beets, unloading the cars, and removing the pulp, about 125 men. Important improvements have been made since last year in the machinery, which is now equal to the best in Europe. Last week the product of sugar and molasses from the cut and sliced beets was over 11 per cent. of the whole. The factory consumes at least 25 tons of coal per day. Work is pushed day and night without cessation, except one hour at noon and at midnight. From 125 to 150 tons of beets are worked in 24 hours. The company has on hand some 6,000 tons of beets. About 10,000 tons in all will be worked during this season. The factory will probably continue in operation until about Christmas. Beets are now arriving daily at a rapid rate. The cars bring about 300 tons, and farmers' wagons about 50 tons per day. The crops average fully as well as last year, notwithstanding the drought which diminished the yield at least one-third from what it would otherwise have been. The beets are of about the same average quality as last year. They are not so good as in Europe, owing to the improper cultivation and the imperfect removal of the leaf crown, which in Europe is always cut off and retained by the farmers. About two-thirds of the beets are raised in the State of Maine from Bangor, Dexter, Skowhegan, and North Anson to the State line, and from Farmington to Belfast and Rockland. They come by the Maine Central, Knox and Lincoln, Somerset, Grand Trunk, Rumford Falls, and Buckfield, Portland and Ogdensburg, Portland and Rochester, Boston and Maine (?) Eastern, Boston, Concord and Montreal, Passumpsic, Fitchburg, Delaware and Hudson, Hoosic and Western Railroads as far as Schenectady and Fort Hunter, New York.

Beets are sent from the Connecticut River Valley and the Merrimac Valley, New Hampshire, as well as from the eastern townships of Canada. This great area of country supplies beets which all ought to be raised, and as many more, within 20 miles of Portland. Farmers in the surrounding country have generally done well this season. The estate of Cyrus Thurlow, in Deering, has received from the factory this year $430 in cash, and $50 from the sale of tops for greens, making nearly $500 cash product from three acres of land.

With a full supply the factory could work with the present machinery in five months 20,000 tons of beets, which would turn out 2,000 tons of sugar and molasses in a single season.

Last year the waste products were largely lost for want of a demand for them. This year the waste has all been bought for manure by one of our interprising citizens, at the rate of $1 per ton. Over 2,000 tons of beet pulp are already sold in advance at the above rate, and the demand for it has far exceeded the supply.

EXPERIMENTS IN DELAWARE.

Another experiment in the cultivation of the beet and its manufacture into sugar has been made in the State of Delaware. To encourage the enterprise the State legislature appropriated $300 in 1877 to be offered as premiums to farmers for crops of sugar-beets, and in 1878 $1,500 were appropriated for the same purpose.

Beet culture was begun four years since, and results proving better with each succeeding year, the experiment of making beet sugar was undertaken in 1878 by the Delaware Beet Sugar Company with such imperfect apparatus as happened at hand. The crop to be worked up amounted to 350 tons of roots (containing an average of 9 per cent.

of sucrose) from 75 acres. From imperfect arrangements these experiments were not very satisfactory. Unfortunately the past season proved very unfavorable to the beet crop in the State, again bringing the supply of roots below the requirements of the company, whose new and complete mill, made by Colwell Brothers, of New York, and costing $30,000, has a capacity of 60 tons of roots per day of 24 hours, gives employment to 42 men, at average wages of $1 to $1.25 per day and consumes daily 20 tons of fuel, costing, delivered at the factory, $1.75 per ton. With the very small quantity of material they have had to work up this year the company has yet realized enough to cover all the running expenses. With such a crop as was expected a fair profit would doubtless have resulted. As it is, the company has been so encouraged that measures are now being taken to secure contracts for a crop of 2,000 acres of beets, and an increase of the capacity to 100 tons per day, if the requisite quantity of raw material can be contracted for. The work in the factory has not been far enough completed to give accurate details as to the results obtained. Enough is however known to determine that the yield in sugar from the centrifugals and of the first crystallization, testing 95 per cent., will reach 100,000 pounds, for which 8 cents per pound has been offered. The molasses is still to be worked over for seconds, after which the residue will be delivered, according to contract already made, for 18 cents per gallon. The pulp from the diffusors amounting to from 40 to 45 per cent. of the weight of the roots worked is readily sold for $1 per ton, delivered on cars at the factory. Indeed, more orders for pulp have already been received from the farmers than can be filled this year. As this company seems to lack neither capital, intelligence, practical experience, nor transportation facilities, its ultimate success may be confidently predicted.

If, as stated, the implements used in the cultivation of the beet are peculiar to European manufacturers, there would seem to be no good reason why the desire of the growers in this country that they be admitted free of duty, at least until our manufacturers are prepared to supply them, should not be allowed.

LOUISIANA SUGAR.

In its earnest efforts to promote the sorghum sugar industry, as adapted to the whole country—and the more earnest because adapted to the whole country—the Department of Agriculture does not overlook the importance of the cane-sugar production in Louisiana and a few other Southern States to the citizens of those States and to the country at large. In the introduction by the department a year or two since of some foreign varieties of cane, a step has been taken which it is believed will in a few years—and when the imported cane (confined at present to a few planters for propagation and experiment) shall have been widely disseminated—add largely to the Louisiana production. The crop of the past season, though shortened by unusual severe weather in Novem-

ber, will be larger than any made since 1861, the year of largest production. The quality of sugar manufactured is represented to be excellent, much above the average in grain and color.

The success reported by our correspondents as attending the growth of sorghum in Louisiana and Texas, and the demonstration that two crops a year of this species of cane can readily be grown and worked up before frost in all of the extreme Southern States, warrants the belief that the sugar planters of that region will ere long find it to their advantage to substitute in part, if not altogether, the cultivation of sorghum for that of the ribbon cane. Such a change is made the more probable by the fact that from one-sixth to one-third of the sugar lands of the Southern States has to be given up annually to the production of seed cane if intended for the production of sugar cane, whereas the whole could be devoted to sorghum, which produces its own seed and yields a full crop of sugar beside; and, further, that ribbon cane, from the time required for ripening, is frequently overtaken by frosts, whereas two crops of sorghum can be grown there during the same time without danger of being so overtaken.

The repeated experimental examinations made by Dr. Collier in the laboratory of the department furnish satisfactory evidence that sorghum cane is the equal of sugar cane in saccharine matter, yields as much per ton, is more easily cultivated, and can always be planted after frosts have ended in the spring, and before they begin again in the fall; and the Louisiana planters, who have not been wanting ini ntelligence to detect, and in readiness to adopt, methods that are useful, will be quite sure, we think, to profit by the opportunity that sorghum affords.

DIVISION OF STATISTICS.

The number of chief correspondents and their assistants who report regularly to the Statistical Division of this department is about four thousand. These are necessarily selected from among persons whose interest in scientific and practical agriculture induces them to serve in this capacity, without other remuneration than the receipt of the publications of the department, and such seed as the department distributes from time to time. The information given by these correspondents forms the basis of all our records of the condition of the crops and of other estimates. Evidence of the intelligent and truthful manner in which these reports are made and with which they are collated and arranged, is to be seen in the fact that the reports of the division published from month to month are sought for, not only by the farmers of our own land, but by members of Congress, boards of trade, and business men both here and in foreign countries. The clerks of this division have been actively employed in estimating the increase or decrease in areas of every principal crop; in preparing for publication the monthly reports of the condition of crops, comparing the same with their condition in other years, and so estimating their prospective average yield; in tabu-

lating the annual outturn of these crops and noting the causes of failure or success; in computing the number of live stock in the several States and taking note of its condition; in preparing schedules of wages for farm and mechanical labor, and in recording the value of farming lands and the relative increase or decrease in the same throughout the country. The latter investigation is the first of the kind (if we except the weak attempt in 1867) made in the history of the department, and if continued for a number of years sufficient for comparison promises to be of great value in determining the special advantages of different sections for particular purposes. But valuable as is the work already done in this direction, there remains much that cannot be accomplished until an increase of force in this division is authorized and provided for.

The space now allotted to this division should be more than double, and twice the number of clerks now employed would find constant occupation in preparing for publication the necessary tables relative to crops, labor, herds, &c., in listing the agricultural wealth of the country month by month and year by year. As before said, the function of this division is to give to the public the latest phases and prospects of the growing crops, to show the extent of land they cover, to record the influences favorable or unfavorable which affect their growth, to sum up their final product, to estimate their value to the farmer, and to strike the balance-sheet of the agricultural enterprise of each year.

This division is also called upon to investigate the agricultural systems of foreign countries, to compare their results with ours, and to indicate desirable and practicable improvements in our modes of culture. Its great value lies in the accuracy of its reports, which have attracted the admiration and confidence of agricultural and commercial men on both sides of the Atlantic. It is also constantly called upon for information of the most varied character by the public press, and by scientific and business men in all parts of the country. In many instances replies to such requests demand the most careful study and patient research. Such replies can be given only by men thoroughly familiar with our agricultural facts.

I would recommend that this division be enlarged to double its present strength, so as to be able to take up investigations which at present it is unable to touch.

DIVISION OF ENTOMOLOGY.

The field work of this division in progress last year was continued early in this.

During the months of January and February Prof. J. H. Comstock, Chief Entomologist of the department, having been directed to inspect the orange trees of Florida, which were reported as being seriously damaged, proceeded to visit the more important orange-growing sections of that State, and in fact nearly every large orange grove in the State, for the purpose of studying on the spot the habits of the

various insect enemies to the orange trees; of ascertaining the extent of the damages done by them, whether worthy of the attention of the department, and, if possible, of discovering a remedy of practical value. He reports the existence of these insects as very general there, and that the damage in many cases is extensive, entire groves having been destroyed.

While in the State the entomologist collected specimens of all insects found infesting the orange and allied trees, and made as full notes as possible, in the time at his disposal, upon the habits of these insects. Living specimens were forwarded to Washington and colonized on small orange trees in the insect-breeding room at the department. In this way the development of all the more important species from the egg to the adult state has been observed.

Leaving this work to be carried on by certain assistants (the details of which will appear more at length in his report herewith), the entomologist and one assistant were sent out in July to make similar investigations in California, frequent complaints of like injury having been received from the orange growers of that State. They proceeded to Los Angeles, where two months were spent in the orange groves of that section, which were found to be badly infested with what are popularly known as "scale" insects. The life history of these creatures was carefully studied and a series of experiments with remedies carried on. The other orange-growing sections of the State were also visited; and later, the entomologist examined the orchards of the Santa Clara Valley and found that the deciduous fruit trees suffer from the ravages of scale insects even more than do trees of the citrus fruit family in the southern part of the State.

Having ascertained at the outset of the investigation that the scale insects are much more destructive to fruit trees than any other pests, a special agent was employed during the summer months to experiment with various substances for their destruction. These experiments, taken with those conducted by the entomologist in California, have produced very valuable results in the finding of remedies that are both efficient and practicable.

While the investigation outlined above has been the special work of this division, much of a more general nature has been done. The number of inquiries respecting various noxious insects continues to increase, and the answering of these inquiries forms a very important part of the duties of the division. During the present year the collection of insects has been transferred to new and secure boxes; and the work upon the biological collection, which was begun last year, has been continued. This collection now consists of 107 boxes of pinned specimens (of which 35 are scale insects), nearly 1,900 slides of microscopic insects, and many alcoholic specimens.

DIVISION OF BOTANY.

The work of the botanical division has been quietly but steadily prosecuted through the year.

The museum has been rearranged and relabelled, and its cases made more attractive and more accessible to persons desirous of studying the various productions of the country.

About five thousand specimens, many of which were new, have been mounted and prepared and added to the herbarium, which is steadily growing in size and importance, and is now undoubtedly one of the most interesting collections in this or any other country.

The important work commenced in 1879 of describing and illustrating our native grasses has been continued during the past year, and the report of 1880 will be particularly interesting to such as seek intimate and scientific knowledge of our numerous species of valuable grasses.

Such assistance as was possible with the limited means allowed has been extended to agricultural colleges and other institutions of learning desirous of establishing herbariums and agricultural museums.

The correspondence of this division is continually increasing, and serves to diffuse botanical information in its practical and agricultural branches throughout the country.

A botanical collection at all commensurate with the varied flora of so vast a country as this should have far more space allotted to it than is possible in the present building. Every one must see how interesting such a collection would prove to all persons visiting the Capital, and how instructive to every student of agriculture.

The clear presentation to the eye of the number, variety, and nature of agricultural products is a means of public instruction which all civilized countries adopt and acknowledge to be of great value.

DIVISION OF GARDEN AND GROUNDS.

During the season the distributions from the garden have aggregated 156,862 plants of various kinds. Among these were about 70,000 tea-plants, 3,000 olives, 1,000 coffee, and 500 date palms. About 2,000 plants of European wine grapes have been distributed in southern Texas and Florida.

Experiments which have been made point to the probability that the foreign grape will succeed in parts of Texas equally as well as in California, where it has become a staple crop.

The number of tea-plants now propagating in our grounds is not large, owing to an unexpected failure in procuring tea-seed from abroad. Elsewhere will be found an account of the extended effort making, under the auspices of the department and in accordance with the design of Congress in making an appropriation therefor, to give to the cultivation and manufacture of tea commercial importance.

The Japan persimmon has fruited in various parts of the country, and

its reputation, as being a valuable fruit of its kind, has been fully sustained. Its extreme limit of endurance is not yet settled, but that it will be a valuable addition to the fruits south of latitude 39 is already well established.

A large distribution of coffee-plants has been made in Florida and southern California. By forming plantations at various points the practicability of coffee-culture can be decided, and this can only be accomplished by definite experiments in promising locations. A pound of coffee grown and ripened in the open air by Mrs. Julia Atzeroth, of Braidentown, Manatee County, Florida, has been forwarded to this department, and is probably the first coffee ever raised in the United States by cultivation outside of the green-house.

To meet the requirements of this department there are needed at least one thousand (1,000) acres of land in the vicinity of this city, and if possible in the District of Columbia, with auxiliary tracts or stations in various parts of the United States, and with the requisite buildings and force for working the whole to the best advantage.

The principal station or farm—the one established in this vicinity—should be devoted to the experimental cultivation of all the different plants, cereals, trees, &c., suitable for a climate similar to that of Washington, and especially to the hybridization and production of varieties differing from and better than those now in use. These should be raised here and on the auxiliary farms in quantity sufficient to provide all the seeds, &c., to be distributed by the department; thus doing away with the practice of purchasing them in the general market, and getting at the same time better seed at less cost than is now done.

This principal station being at hand, would have the benefit of frequent inspection by the head of the department, who would thus be constantly informed of its work and of its requirements, and in position to quickly make any needed change or reform. Here, too, the scientific and financial resources of the department could be promptly availed of in any sudden emergency.

The auxiliary stations should be located at points remote from the parent farm and from each other, and have as their prime object careful, practical, and scientific experiments to determine the suitableness, or the contrary, of different cereals, plants, &c., for the several sections of country in which the stations are established. In this way would be demonstrated, at the expense of the government (as it should be) rather than at the cost of her private citizens, and in a far more intelligent and decisive manner than is ordinarly the case with the individual experimenter, the economic value and peculiar adaptation (or the reverse) to particular localities of many agricultural products now but little understood.

Here, too, as at the principal station, would be grown for distribution cereals, plants, and the like, the success or failure of which in the hands of the recipient would determine the extent of production at any one station.

These auxiliary stations should be temporary or permanent, large or small, as the case might require. For special purposes it might be necessary to hire and occupy small tracts of land for two or three years to carry out experiments to be completed within that time, while land for more constant use should be held by permanent tenure.

The results to be obtained from such principal and auxiliary farms would be valuable beyond all estimate.

A tract of land more or less suitable for the principal farm and already belonging to the government is the well known Arlington property south of the Potomac. The national cemetery occupies but a small part of this estate and could not possibly militate against the establishment of the experimental farm in question. Though a good part of the land is quite infertile, it could soon be made, from its proximity to a great city whose sweepings would be available, to answer the purposes sought. I would therefore urgently recommend that authority be given to the department to occupy this property, and that the appropriation necessary to carry out the object here indicated be made during the next session of Congress.

I here take occasion to renew the recommendation made relative to another department building as being a necessity for the accommodation of its employés, the number of whom must necessarily be largely increased to be at all commensurate with the work to be done. This building should be erected upon the ground at present occupied by the gardens in rear and at the sides of the existing department building. It should form a hollow rectangular parallelogram, with a front of about 1,000 feet by a depth of about 500 feet, and should include an interior covered court. The building itself should be 80 feet in width, with suitable halls, &c., and with a piazza of proper width around the four sides of the court. It should be fire-proof and well ventilated, and be arranged for offices, for the storage and handling of seeds, and for the continuous exhibition of the agricultural products of this great nation.

There should be provided also ample space within for the display of all implements employed in agricultural pursuits (and I am informed that working models will be furnished by the manufacturers thereof, if the government will provide the building). The interior of this hollow parallelogram should be covered with a glass roof supported on pillars of sufficient height to accommodate, as at the Kew Gardens, those trees and plants that are valuable for economic or ornamental purposes. The early erection of such a building cannot be too strongly urged. Looking to its consummation upon the scale suggested I have had drawings prepared which are herewith submitted.

DIVISION OF SEEDS.

By the act of Congress making appropriations for the purchase and distribution of seeds, &c., an entirely new departure in the mode of distribution was made necessary. This act requires that "an equal pro-

portion of three-fourths of plants, seeds, and cuttings shall, upon their request, be supplied to Senators, Representatives, and Delegates in Congress, for distribution among their agricultural constituents, or shall by their direction be sent to their constituents, and the persons receiving such seed shall inform the department of the results of their experiments therewith." In conformity with this provision notice in writing has been given to Senators, members of Congress, and Delegates of the reception of seeds, &c., at the department for distribution, and that an equal proportion thereof was held subject to their order. Some have neglected the notice entirely; others have positively declined to have any charge or care of the distribution of seeds; others have sent lists of persons to whom they wished them sent; while others made return that at some future and more convenient season they might find time to forward directions relative to the disposition of their quota of seeds. The difficulties attending this method of distribution are apparently insuperable; for under this rule the department must hold in reserve for members of Congress living in the North cotton and other seed only useful in the South, and for members living in the valley of the Mississippi, seeds that are of use only on the Atlantic and Pacific slopes. Again, the distribution is rarely made in season and not then in sufficient quantity.

I feel it my duty, from what I know of the injurious working of this system, to recommend the adoption of the method of distribution suggested when I had the honor to appear before the Sub-Committee on Agriculture, on the 18th day of January last, and embodied in a letter addressed to the chairman of that committee bearing date February 27, 1880.

The following is a summary of the distribution of field and garden and flower seeds during the year:

	Packages.
To Senators and members of Congress	759,679
To agricultural societies	17,444
To statistical correspondents	139,729
To granges	355,452
To special farmers	127,644
To miscellaneous applicants	181,305
Total number	1,581,253

This division is now crowded into the basement of the present building; and not only is its space insufficient but its ventilation so bad as to cause illness among the employés and seriously to impair health. That from twelve to twenty persons should be employed in a room not twenty feet square, and which is cumbered at the same time with the material they are at work on, is something that surely ought to be remedied. There is no other way than by the erection of a new department building, for notwithstanding the employment of every known means in economizing and facilitating the work of this division it has been impossible to do it as it should be done in so cramped a space and with so small a

force. However opinions may have differed heretofore, it is now generally conceded that the distribution of seeds from this department is doing incalculable good.

The increased production per acre of wheat and oats alone which has resulted from our distribution of those cereals during the past few years should suffice to convince the most skeptical of the great value of this work. Taking the last three years as compared with the three previous years, the increase in wheat was 2 bushels per acre. This in forty millions acreage yearly would be eighty millions of bushels increase, or a gain to the country of about $80,000,000 per annum. Assume, however, that we make, by a judicious distribution of improved seed, but one additional bushel on this acreage, and the increase to the wealth of the country from this source alone will not be less $40,000,000 per annum.

I do not think it at all impossible so to hybridize and improve wheat through the instrumentality of such farms as I have hereinbefore recommended to be established, as to increase the general production of this cereal 5 or 6 bushels per acre. Our correspondence shows that in some localities an increase to this extent has already occurred.

A comparison of present with former yields will show a like increase in the quantity produced and in the value to the nation of other staples which have been the growth of seed distributed through this division of the department.

In portions of the country the increase in oats—an increase clearly the result of our distributions—has been as high as from 10 to 20 bushels per acre. Need more be said to demonstrate the importance of giving wider scope to the usefulness of this division?

MICROSCOPIST.

The microscopist has been engaged during the past year in making microscopical observations of vegetable and animal fibers, parasitic diseases of plants, &c. He reports that among the most prominent of these investigations are those relating to a new blight of the coffee plant, to wheat rust, apple and pear tree blight, orange-leaf blight, orange-tree rust, to diseases of the plum, and to one form of potato rot. He also reports the discovery of a method of treatment with sulphuric acid, by which the germinating power of seeds will be quickened, and that applied to cotton seeds has the effect of removing the fiber therefrom, making it possible to plant the seed with greater regularity than is now done, and by horse or hand power drill.

FOLDING ROOM.

This room, like the rooms in the seed division, is in the basement of the present building. From it are sent our annual as well as our special reports, and our monthly and special circulars—a vast amount of printed matter. Crowded in a small space, the employés are hindered greatly in their work. As in the seed division the air here is exceedingly foul and

unwholsome.. No system of ventilation can sufficiently remove the impurities of the atmosphere in so confined a space contiguous to boilers and machinery. No remedy will suffice but a change of location. And no change of location can be made until a new building is erected.

DISBURSING OFFICE.

The following is an exhibit of the appropriations made by Congress for the department, the disbursements, and unexpended balances for the fiscal year ending June 30, 1880:

	Amount appropriated.	Amount disbursed.	Amount unexpended.
Salaries	$66, 900	$66, 900 00	
Collecting statistics	10, 000	9, 978 33	$21 67
Purchase and distribution of seeds	75, 000	75, 000 00	
Experimental garden	6, 600	6, 600 00	
Museum	1, 000	1, 000 00	
Furniture, cases, and repairs	4, 000	4, 000 00	
Library	1, 000	1, 000 00	
Laboratory	1, 500	1, 500 00	
Contingent expenses	8, 000	8, 000 00	
Postage	4, 000	4, 000 00	
Improvement of grounds	6, 500	6, 500 00	
Investigating the history and habits of insects, &c	5, 000	5, 000 00	
Investigating the diseases of swine, &c	10, 000	10, 000 00	
Printing and binding	11, 000	10, 116 71	883 29
Total	210, 500	209, 595 04	904 96

Under the recommended enlargement of the department the increased work of the disbursing office would require additional space and force. The business of this office is to audit and pay all accounts, as accounts for salaries and for purchases of all sorts. To it properly pertain the duties of the property clerk and the superintendence of buildings. With an enlarged department the officers should be as follows: One disbursing officer, one assistant disbursing officer, one property clerk and assistant, and one superintendent of buildings, and one or two clerks of lower grade.

PRINTING.

The delay in getting the annual report of the department before Congress for distribution to the people of the country is something that can and should be remedied. The report of 1879, which should have been put into the hands of Congress for distribution before the adjournment of the early session in 1880, is not yet out of the Government Printing Office, and will not be in the hands of the farmers until the spring of 1881, entailing the unnecessary loss of a whole year. If the department was intrusted with its own printing it could be done in a reasonable time, and with no more expense than is now incurred in the Government Printing Office, which appears to be so overburdened with Congressional and other work that the large edition of the annual report of the Department of Agriculture required is not and cannot be commenced until midsummer of the year following the one for which the report is made. The edition of our annual report is usually 300,000,

and while larger than that of any annual book ever published, is not yet half large enough to meet the reasonable and pressing demand. The plain remedy is to intrust the printing of the department to the care of the department itself, and thus relieve the overtaxed Public Printing Office, while securing the prompt and timely execution of the work under the direction and care of those most interested in having it done properly and promptly, which I am convinced is otherwise impossible.

TEA.

The unflagging efforts of the department in the introduction of the tea plant and the manufacture of tea as a commercial product have this year borne fruit, giving promise of a complete realization at an early day of our most sanguine expectations.

At my solicitation and advice, Mr. John Jackson (a native of Aberdeenshire, Scotland, who had been attracted, while traveling in this country for his health, by the publications of the department on the cultivation of the tea plant), visited the Southern States, and having satisfied himself, after thorough examination, of the fitness of soil and climate and the feasibility of making tea of such quality and at such price as would enable the grower and manufacturer to compete in the markets with the tea grower of India, China, or Japan, purchased the estate of Dr. Jones in Liberty County, Georgia, on which were growing patches of neglected tea plants of all sizes, most of them having sprung from a few old trees set out by Dr. Jones in 1850 or thereabout, and the seed of which ripening and falling had taken root and grown into a dense brush or tangle of plants of all ages. Mr. Jackson took these neglected and indeed abandoned plants in hand, laid out a tea garden of one hundred acres, transplanted his smaller plants and obtained others from the stock of the department and from wherever in the South a few could be had suitable for transplanting, and has now one hundred and sixty thousand plants, occupying about forty acres of ground. From the leaves of the older plants he has made samples of tea during the entire spring, summer, and fall months, which have been submitted to the experienced judgment of some of the oldest and best tea houses in the United States and London. Mr. Jackson's report and such of his letters to the department as will prove instructive or interesting or serve to encourage the employment of capital in the production of tea in portions of our country to which it is adapted, will be added as an appendix to this report; as will also the statements of a few of the well-known experts who have examined and passed judgment on the samples submitted to them for appraisal.

Acting under authority of Congress, I have selected, after a careful examination, with the aid of Mr. Jackson's experience, a tract of land suitable for an experimental farm on which the raising of tea on an extended scale will be carefully and thoroughly tried. Of the result there can be no reasonable doubt. American tea, grown and manufactured

on our own soil by ourselves, is destined at no late day to supply the demand of our own people and to enter the world's market in favorable competition with that produced by any other country.

ARTESIAN WELLS.

At the last session of Congress it was provided:—

> That with a view to the reclamation of the arid and waste lands lying in certain Western States and Territories, the Commissioner of Agriculture is hereby authorized to contract for the sinking of two artesian wells on the plains east of the Rocky Mountains; said wells are to be sunk at such places as the Commissioner of Agriculture shall designate. * * * The sum of $20,000 is hereby appropriated to carry out the objects of this provision; the same to be disbursed under such rules and regulations as the Commissioner of Agriculture shall prescribe.

Acting under the above provision and appropriation of Congress, I proceeded to make an examination of the arid country lying on the eastern slope of the Rocky Mountains in Colorado. There are large areas of land in this region now lying unoccupied except by wild beasts, and at times by the increasing herds of ranchmen, who, having possessed themselves of the few springs or streams, practically use and control millions of acres of. land belonging to the government, for which they pay neither rent nor tax. An examination and study of the geological formation of this locality warrants the belief that water-bearing strata may be found which, fed by the melting snow of the mountain ranges, would furnish flowing streams of water that will serve to bring much of this arid region into market; and the many natural advantages of the country make it absolutely certain that whenever the government shall have demonstrated the existence of water there and the feasibility of tapping it, entry of the land will be made by those who now pasture it, and other persons be able to dig or bore wells at their own charge.

For the first trial-well, I selected the arid plain a few miles from the Arkansas River, adjoining the military reservation of Fort Lyon, which is about midway on an east and west line below the western limit of cultivated lands and the mountains, that is to say, about eighty miles east of the mountains and out upon the great plains. If water can be obtained here, encouragement will be given to try other wells in more difficult places where the water is probably further from the surface, and whose remoteness from settlements makes the hauling of supplies a matter of too great difficulty to be undertaken now with the means appropriated for this year's experiment. For the purpose of exploring the geology of the country a well in the middle of the Arkansas Valley would be as valuable as elsewhere. The location of the present well is so far above the Arkansas River that there will be opportunity to use for irrigation all the water that can be discharged, while if the well had been located twenty or thirty miles from the river, the appropriation would not have covered the transportation of food supplies, of fuel and water for engines, and of boring tools.

After a careful consideration of the object to be accomplished by the exploration for which the appropriation was made, I decided upon the

diamond drill as the tool that ought to be employed, since by its use a core sample of the formation passed through, valuable for comparison with the cores to be taken from the second well authorized, would be obtained. As there was no machine suitable for the purpose in the hands of the manufacturers, the work was necessarily delayed until one could be fitted up specially for the purpose and shipped from the shops of the American Diamond Drill Company at Pottsville, Pa. This was finally completed, and with all the necessary tools shipped to Fort Lyon, where it is now at work under the direction of an expert and trusted drill man, Mr. M. C. Griscom, recommended to me by the above named company, in whose service he had been sent to Australia in charge of and to introduce and operate one of their drills. He is prepared with rods and material to bore 2,500 feet in depth, and is now at work, making reasonable progress from day to day.

FORESTRY DIVISION.

The very important work in the preliminary statistical and geographical, as well as economic examination of the forest products of the United States, is still continued by that active, untiring, and intelligent scholar, Dr. Franklin B. Hough, whose labors for the department in this direction have met with the approval and commendation of scientific and practical persons, not only in the United States, but in foreign countries. Applications for, and the highest approbation of his work, as published specially by the department with authority of Congress, have been received from every part of the world. The work for this year, it is believed, will not be less important when completed than heretofore, and an appropriation for its continuance, and for the publication of a large edition of his special report, is recommended.

INTERNATIONAL SHEEP AND WOOL SHOW.

By act of Congress April 1, 1880, I was authorized and directed to attend in person or by deputy the International Sheep and Wool Show to be held in the Centennial buildings, Fairmount Park, Philadelphia, in September, A. D. 1880, and to make a full and complete report of the same. With such assistance as was necessary to carry out the intent of the law, I was present at the opening and continued through the exhibition, obtaining samples of the wool of the different sheep exhibited, and such facts and information as was necessary to a compliance with the requirements of the law. A full and complete report of the exhibit and of the information obtained is in course of preparation, and will be forwarded to you for the information of Congress as soon as completed.

SILK CULTURE.

The efforts of this department in the encouragement of silk culture have been entirely frustrated during the past season by the loss of the silk-worm eggs forwarded to the department, from having been kept while in transit in so warm a place as to hatch out and die before reach-

ing us. This is much to be regretted, as the interest awakened, if we may judge from frequent inquiries, will necessarily flag for a time, and renewed efforts be required to induce the people to again undertake the experiment of raising cocoons for market or home use.

One great obstacle to the growth of this industry, the want of an assured market where fair prices could be obtained for the cocoons, would be removed by the establishment of a reeling factory in connection with this department, where experts should be employed not only to carry on the work, but to teach all desirous of learning the art of making silk. Such an establishment would come fully within the intended scope, as I understand it, of the department of agriculture of every government recognizing the importance of developing all new and profitable industries for its people. England has recognized the wisdom of this policy in bounties for useful inventions, and in almost lavish expenditures to build up such industries as tea, and cotton, and sugar in her colonies. France gave recognition to it when, with prophetic wisdom Napoleon created an industry (the production of sugar from the beet), that has placed her to-day in the front rank of the sugar-producing countries of the world. Germany and other European countries have manifested their recognition of it by lending the power of the government to the advancement not only of the sugar industry, but of others not less considerable. With these examples before me, I have no hesitation in recommending that you urge upon the attention of Congress the importance of affording government aid to the undertaking here suggested, long enough at least to educate our people to the work. Many persons whose time would otherwise be of little or no value, would thus find profitable employment in rearing silk worms and eggs; work so light that children and delicate women could perform it in their lowly cottages, and with the money obtained from the cocoons and eggs and reeled silk procure comforts of life not otherwise to be possessed.

GRAPE CULTURE AND WINE MAKING.

A special study of the subject of grape culture and wine making was commenced in 1878, and advantage was taken of the presence of Dr. William McMurtrie, the agent and representative of the department to the Paris Exposition in France, and he was ordered to make an examination of the methods and practices followed in Europe, and a collection of facts and statistics relative to the industry in France and Italy. This was accomplished with as much accuracy as was possible considering the short time and limited means at his command, and report thereof made on his return. But before placing the results of this work before the people, it was considered advisable to obtain information concerning the methods already adopted in the United States, and the condition of the industry up to the present time. A circular of questions concerning soil, climate, culture, diseases, wine making, cost of installation and management, and statistics of production was prepared and distributed.

While in the replies there was almost a general expression of inability to give satisfactory statistics of the average production of the section, they show that in many parts of the country great interest is manifested in the industry, and that it is carried on with intelligence, skill, and success. Among these we may more especially mention Central New York, Southeastern New Jersey, Virginia, Northern Ohio, Michigan, Iowa, Missouri, Texas, and California. The replies also fully illustrate the necessity of furnishing American wine producers with complete and detailed information concerning the methods that have been adopted in Europe after long years of experience and study relative to the various diseases which infest the vineyards and are a continual source of great losses to the producers, and materially impede the advance of the industry. Rot, mildew, and insect injuries are reported from almost every State, and the determination of simple and ready means of obviating these causes of loss are greatly desired. The information secured in the replies to the circulars have been tabulated and will be discussed in connection with the information secured from abroad, and it is hoped that in the results of the work American grape growers and wine makers may find much to adopt for the increase and improvement of the product of their vines.

Partial statistical returns received at this department indicate that the wine made during the year 1880 may reach the gross amount of 30,000,000 gallons, worth at least twenty million dollars.

PLEURO-PNEUMONIA CONTAGIOSA?

Under the act providing for an inquiry into the contagious diseases of domestic animals an investigation of pleuro-pneumonia was commenced, the result of which should declare if possible the exact extent of territory in which there existed any cattle affected with contagious pleuro-pneumonia, on account of which the Government of Great Britain had placed a restriction upon all cattle coming from the United States. After due time and a very thoroughly conducted investigation this territory was defined to be one extending at that *time* from Fairfield County, Connecticut, over New York City, and portions of the State of New York lying just north of it, Brooklyn, L. I., and parts of the island lying just east of it, Jersey City and parts of New Jersey, Philadelphia, and some of the more easterly counties of Pennsylvania to Baltimore, and over portions of the more northeasterly counties of Maryland (see map of this district accompanying Special Report No. 22 on the subject). Further than this in no locality was it possible to find a case of the disease, although efforts were made in all directions and especially among the cattle coming from the same parts of the West as did most of the cattle going to Great Britain. Previous efforts of this department, together with this examination, had aroused several of the infected States to action, and efforts made by efficient officers in those States to exterminate the disease have been measurably successful so that the infected

district represented by the map in Special Report 22 may now be corrected and the area very much reduced. Mr. J. C. Edge, secretary of the board of agriculture of Pennsylvania, having charge of this matter in that State, reports that no known case, now December 1, 1880, exists in the State of Pennsylvania outside of two herds, both of which are strictly quarantined.

Reports being constantly received, however, from England that cattle were being landed there affected with pleuro-pneumonia, a very short investigation on this side demonstrated clearly that these animals so reported upon came directly in nearly all cases from the West, and over lines of rail that were entirely away from any point at which we could locate the disease. The next step therefore seemed to be to carry the investigation to the other side, to see the diseased cattle as landed there and by means of way-bills, &c., to trace them back to their original starting points in the West, and so accomplish the object of the investigation, viz., to find *all* the infected territory. An entirely competent person for this work was selected in the person of Dr. C. P. Lyman, a graduate of the new veterinary college, Edinburgh, and well known as a veterinary surgeon in Massachusetts, his native State. So well has this gentleman acquitted himself in the discharge of this delicate and important duty that chiefly upon his action a modification of the existing order of the English council has been proposed.

Out of nearly eleven thousand beasts landed and examined in Liverpool during the stay of our inspector there, in no one of which could pleuro-pneumonia be detected in the living animal, the inspector of the veterinary department of the privy council condemned, after post-mortem examination of the lungs, only six cases. These six cases have been traced, and in all of them but one we find that the animals undoubtedly came from the West and over lines of rail entirely north of the localities which are known to be contaminated, the fact being that a good part of the eastward journey was generally made through portions of Canada. If pleuro-pneumonia exists in the West at all, or there are diseased centers in or about the points of shipment or along the routes over which the cattle passed on their journey Eastward, the information that we now possess will, it is hoped, enable us to fix the exact location after time for further examination; but there is another view of the matter which is of the utmost importance, and that is that the disease passed upon by the English inspectors *may not be the true contagious pleuro-pneumonia*, although resembling it so closely that skillful and experienced surgeons on ordinary examinations of the lungs of the cattle condemned as diseased and slaughtered in Liverpool did not hesitate to pronounce it true contagious pleuro-pneumonia.

Dr. Lyman, who ever since his return from England has been engaged in this inquiry, aided by skilled microscopists, says:

All that at present can be said is that the particular lungs exhibited present in their fresh state and to the naked eye all the lesions of the contagious disease, but on a very small scale, and in addition another lesion, which is constantly present in their

condemned lungs, which has never been described by any authority or noticed heretofore by any of our veterinarians to be a constant or even a known accompaniment of the disease.

What weight this fact may have upon the whole of this question, further pending investigation will probably soon decide. Whether these cases are or are not true pleuro-pneumonia is a matter which does not, in the mean time, have much bearing upon the question of the removal of the English embargo. While we have pleuro-pneumonia in any part of our country, and certainly while we have no national legislation looking in any way towards restricting its spread and eventual total suppression, just so long will the embargo continue to operate against one of the greatest of our commercial interests, and to lay that portion of our agriculturists in the West that are engaged in the raising of fine beef bullocks under a very severe and unmerited tax, one which, in the estimation of a very good judge of the matter, has reached during the present year to a sum upwards of $2,250,000. What are the actual losses sustained from the presence of the disease by those farmers and dairymen in the East who are unfortunate enough to be located in the midst of a contaminated center it is very hard to say, but that the annual losses by death alone can be no very light tax to them is a safe conclusion.

Again, although it is yet possible to exterminate this foreign plague from among our herds while now confined, as we believe, to animals that are kept upon fenced farms, should it once, by any misfortune, be carried among the great herds of the West that feed upon the unfenced ranges, its extermination would become impossible, and this great and growing interest of our whole West, from Texas northward, would be permanently mortgaged (with foreclosure continually impending), notwithstanding any effort that might then be made to eradicate it. The remedy now for all of this is plain, and one of comparatively easy accomplishment, viz., let Congress enact such measures and authorize such an execution of them as shall immediately restrict the movements of diseased cattle out from infected districts, and in time eradicate every case of this pestilence of foreign origination from among our herds. This enactment should also require strict quarantine of all animals coming to our shores, either directly or indirectly, from contaminated foreign countries.

TEXAN CATTLE FEVER.

This disease, described in a report to this department in 1871 by Professor Gamgee, although it has never as yet reached England, and therefore has never been put upon the schedule as a contagious disease coming from the United States and requiring restriction, is yet for a short time each year a very important source of losses to Western and Northern cattle growers and shippers. Beginning generally toward the last of July it extends with increasing destructiveness until the time of frost. Western and Northern cattle brought in contact with cattle coming from Texas which themselves seemed perfectly healthy perhaps, con-

tract the disease from them, and with these it is often very fatal, killing sometimes as high a proportion as 90 per cent. of the exposed animals. It is a well understood peculiarity of this disease, however, that it cannot be communicated at second hand, *i. e.*, that while the disease is communicated by the Texans to animals in a more Northern country through which they pass, and with these animals is nearly always fatal, yet it is not communicated by the latter to others. Its incubation may be from fifteen to forty days, and during this period the animal may be shipped from the West and slaughtered in the East, and we may again have the distressing state of affairs reported by the Metropolitan Board of Health to have existed in 1868, when an increased death rate in the city was traced directly to a consumption, as human food, of the flesh of animals sick with this fever, or the animal may be placed on board ship and started for the English market, where it is destined seldom if ever to arrive; for, dying in mid-ocean, it is thrown overboard, a total loss to its owner or those insuring. In this way some immense losses are contracted by the shippers in addition to very considerable ones by the dealers all over the West, North, and East. But the greatest sufferers of all perhaps are the breeders and feeders who are unfortunate enough to be located in the States through which the Texans journey to market. This year the States that have suffered more particulaly in this way are Missouri and Illinois. An idea of how these different losses occur and how they are divided up can be had from the following statistical facts:

During June 10,642 beasts were shipped to Liverpool alone. Of these 114 died, a loss of a little over 1 per cent.

July, 12,137 shipped, 110 died, loss little less than 1 per cent.

August, 9,464 shipped, 272 died, loss little over 2 per cent.

September, 10,826 shipped, 619 died, loss over 5 per cent.

That is, the actual money lost in September was $67,662.50 in excess of the loss in June. This excess of loss is thought by the insurance people to be entirely due to Texan fever, and to verify this we have the following quotations of insurance rates:

1st. The Canadian and English companies charge in August 2¼ to 2½ per cent. from Montreal.

2d. At the same time the rate on American cattle from Boston was from 3 to 6 per cent., the higher rates obtaining against Missouri and Illinois cattle.

3d. During September the Canadian and English rates from Montreal were 2¾ to 3 per cent.

4th. The rates on American cattle during the first half of September were 5 to 7 per cent.; the second half of the month they were 5½ to 10 per cent.; Ohio cattle could be insured to from 5½ to 6 per cent.; Missouri from 6½ to 10 per cent.

These differences in insurance make a total difference in the cost in England, of a cargo of say 300 beasts of $2,635 against Missouri, $1,312

against Ohio, as the extreme Canadian cost is but $1,125. Of course these "rates" are based upon the actual results of experience. Being so, the question at once suggests itself, What is the cause for this difference in experience between the United States and Canada? To this the unqualified answer is that it is due to a proper veterinary inspection under proper laws, both of which are rigidly maintained by the Canadian Government. To show how much can readily be accomplished by well maintained inspection alone, I quote from a letter received from a prominent insurance firm of Boston, who have this year employed such inspection, and who would accept no "risks" on cattle unless the lot was passed by their inspector. October 27, 1880, they write: "We have made this list of ours to include the whole sickly season; it shows a loss of one and one-fourth per cent., and would show much less had we not taken a small line on 'Brazilian,' which ran into a gale on first day out. The loss on uninspected cattle during the same time has been upwards of 6 per cent."

When it is remembered that this inspection is only undertaken during the "sickly season," and to prevent the ill results arising from Texan fever alone, the facts are full of significance.

As affecting the breeders of Missouri and Illinois, it may be said that in Boston, October 5, cattle for shipment were selling at the following prices: Ohio cattle, among which there is the least risk of Texan contamination, 6 to 6¼ cents; Illinois steers, 5¾ cents; Missouri, 5½ cents. That is, the Missouri farmer loses about $15 a head on his steers, and he has to stand not only this severe loss, but in addition, during these months, the constant risk of having his herd contaminated and the additional loss by death from such contaminations. The remedy for this is plain, and already indicated by the methods of the Canadian Government, viz., proper laws properly executed; which laws can be made so that while no injustice is done the Southern breeder they will protect the interest of the Western, Northern and Eastern breeders, traders, and shippers.

FOOT-AND-MOUTH DISEASE.

This disease has been landed in Great Britain in several instances among cargoes of sheep, and once in a cargo of bullocks from the United States. This is a scheduled contagious disease, and these animals are now under restrictions because of it; which, of course, as long as the pleuro-pneumonia restriction remains, does not really make any difference; and probably any measures that will provide for a proper veterinary inspection will prevent any further trouble from this source.

In the recent report of the veterinary department of the privy council of Great Britain to the house of lords the statement was made that a cargo of sheep suffering with aphthous fever, or foot-and-mouth disease, had been landed at Liverpool from Boston Harbor. An order of council closing the ports of England to the further importation of live sheep soon followed this report, and since then they have been restricted to

the same conditions as cattle and swine imported from the United States, *i. e.*, slaughtered at the port where landed. At the time this order was promulgated it was not known that the disease existed in this country, but investigations immediately instituted by the department have convinced me that it prevails in several localities. The malady is scarcely ever fatal, and yields readily to proper treatment. All the information attainable as to the locality in which it prevails and the most effective treatment for its cure and extinction will be given in the annual report to which this is introductory; meanwhile, thorough inspection before shipment should stop any further trouble from this source and remove the restriction.

SWINE-PLAGUE.

This is also a disease occasionally carried from this country to England, and which it is now believed can be brought under such control as will prevent in future much of the loss hitherto sustained by breeders and shippers, and may in time banish it in great part, if not entirely, from among us. Dr. H. J. Detmers, who has had ample opportunities for observing the disease in the swine-raising regions of Illinois, and devoted much of his time for more than two years in careful scientific experiments in regard to it, claims to have proven, that inocculation with cultivated micrococci will, as a rule, produce a mild form of the plague, which he regards quite as efficient as a more severe attack in exempting from further contagion. During the past year he has experimented with a large number of preventives, and finds that carbolic acid, when given in suitable doses in drinking water, is a reliable agent, provided its administration is attended with a strict separation of healthy from diseased animals. It should be given as soon as the disease makes its appearance in the vicinage, and continued as long as there is any danger of infection. It may be given regularly three times a day for three weeks, without interfering in any perceptible manner with the thrift, growth, or appetite of the animal. If given after decided symptoms of the plague have appeared, it does not seem to change in any perceptible degree the progress of the malady. He says that while carbolic acid does not destroy the micrococci it appears to prevent conditions necessary for their development, and that although swine so treated may show slight symptoms of the plague, yet no serious danger need be apprehended. A full account of his interesting experiments, as well as those of Professor Law, of Cornell University, engaged in like inquiries, and of Dr. Salmon, veterinary surgeon, employed in the investigation of chicken cholera, will be published in full hereafter. Professor Law's experiments, which were commenced in July last, for the purpose of determining the liability of swine to a second attack of the plague, after having suffered from a mild attack,

induced by inocculation from cultivated virus are not at this writing complete. He says:

So far the observation seems to show that the inocculation with virulent matter cultivated at a rather low temperature in the media named, seemed to protect pigs against a fatal attack of swine-plague, but it is desirable that the matter be tested much more extensively before any general assurance is given to this effect. It is interesting to note that the appearance of a hard nodule in the seat of the inocculation, and its persistence is in keeping with the result obtained by Pasteur in his inocculations with mitigated chicken-cholera virus, and possibly implies a localization of the disease in this seat without danger to the system at large, as is the case also in lung plague in cattle. Ordinary wounds produce no such indurated new formations.

The United States cannot afford any concealment of the truth in this matter of diseases of animals. Our great market for beef and dairy produce is Britain, and the demand of the English people for cheap meat can be met only from America. It would seem from statistical statements that in the year 1874 Great Britain had reached the maximum of meat production possible on the 47,000,000 acres of land under cultivation and pasturage in the United Kingdom.

A writer in the London Times of November 17, 1878, says:

It is a matter of serious national concern that instead of having grown in number, the cattle in Great Britain in 1877 total up 2½ per cent. fewer than last year, and nearly 7 per cent. less than in 1874; that in 1874 we had been losing instead of multiplying in cattle and sheep. At this rate of diminution the number of head of cattle would be reduced to one half in twenty-one years. The truth equally remains that British agriculture is at this moment unable to produce as many cattle and sheep as it possessed in field, fold, and shed only three years ago; and this in spite of the stimulating prices realized from meat throughout the whole period of this decline.

From this statement and others of similar character, made by various persons interested in the agriculture of the United Kingdom, it is plain to be seen that not only must the British people seek their meat supply from other sources than their own fields, but that the demand will be an increasing one. Their deficiency cannot be supplied from any source as cheaply as from the United States.

Several bills have heretofore been introduced and proposed for Congressional action; none, however, that in my judgment are entirely adequate to the matter in hand; unless the power of the general government can be exercised within the borders of the different States and legally sustained and enforced, it is not worth while to pass any laws, other than those already enacted, authorizing an examination into the disease and the mapping out and defining of its limits, to serve in some sort as a notification to State authorities of a pestilence within their borders that may overwhelm them and prove disastrous to the entire nation. The well-known virulence and fatality of the disease, the terror felt on its appearance by other nations that have experienced its ravages, and the well-understood and dearly-learned fact that annihilation is the only effective method of suppressing and eradicating it yet discovered, certainly warrant the interference of the strong arm backed by the full purse of the general government in whatever broad prairie or corner acre a single case of pleuro-pneumonia may be found.

LIBRARY.

Enlarged accommodations and an increased appropriation for the library is also a necessity. With the present appropriation we are unable to supply the books and periodical literature necessary to the scientists of the various divisions, to say nothing of the many valuable works which, properly found on our shelves, would be interesting to the general reader. An appropriation sufficient to have the library properly catalogued, and thus more available for ready reference, should be made. Although quite useful as it stands, it is wanting in essential things. It has now between 7,000 and 8,000 volumes. It should contain many more, and especially should it embrace every book that has ever been published on agriculture.

One thousand dollars has been the usual annual appropriation for maintaining it. Even if to be confined to the present close quarters, $3,500 annually is the least that should be devoted to it.

VETERINARY.

The ravages of disease in this country among various animals of economic value have become alarmingly great. How this destruction which has taken and is taking millions from the wealth of the nation may be stopped and its recurrence be modified if not entirely prevented, is a subject which demands the immediate attention of the government. In no way can the remedy be made so effective as through a suitably organized division of veterinary science attached to this department. Our correspondence, as already established, and ramifying every nook of the country, and other facilities peculiar to the department, would enable us to be informed of the existence of diseases, to investigate them and to apply remedies, and all in such manner as could be done through no other agency at anything like the same cost. The health of the people and the maintenance of their large and valuable foreign trade in cattle, now grown into an important factor of commerce, alike call for prompt action in the matter, in the direction here indicated.

METEOROLOGY.

Meteorological observations, as determining many useful facts relating to agriculture, would justly engage the attention of a separate division of this department. To that division should be committed the determination and tabulation of all important meteorological information bearing upon agriculture; and for this purpose there should be accommodation within the proposed building, and complete sets of all meteorological instruments.

SALARIES.

It is notorious that the officers and employés of this department receive smaller pay than those of any other department of the govern-

ment. Take by way of illustration the salary of the chemist, a gentleman distinguished for his attainments and for his work in that branch of science. He receives for his laborious and valuable scientific services the sum of $2,000 per annum. Contrast this sum with that paid to a chemist of no more repute or ability engaged last year by the Treasury Department in an examination, at Baltimore, of sugars in which fraud upon the revenue was suspected. Occupied in this investigation five or six weeks only, this scientist received, I am informed and believe, and no doubt fairly earned, within a few dollars of four times the *yearly* salary of the chemist of this department.

Is there, I ask, the shadow of justice in so wide a difference as this? It is well known that men of scientific attainments are not usually money-making men; that their habits of thought and close attention to the investigation of special subjects in a measure lead them away from the acquisition of wealth. Working often from a pure love of science and an ardent desire to benefit his fellowman and without opportunity for pecuniary self-advancement, the scientist should always receive from his country substantial marks of gratitude for the good he has conferred upon its citizens. To place the inequality of salaries which I speak of more clearly before you, I submit the following table:

Department of Agriculture.		*Other branches of the government.*	
Commissioner	$3,500	Commissioner of Internal Revenue	$6,000
		Commissioner of Patents	4,500
		Commissioner of Customs	4,000
		Commissioner of Lands	4,000
		Comptroller of Currency	5,000
		Chief Bureau of Printing	4,500
		Assistant Secretary of the Treasury	4,500
		Register of the Treasury	4,000
Chief clerk	2,000	Chief clerk Post-Office Department	2,200
		Librarian House of Representatives	4,000
Chemist	2,000	Doorkeeper House of Representatives	2,500
		Congressional reporters, each	5,000
		Examiner-in-Chief, Patent Office	3,000
Statistician	2,000	Chief Bureau Statistics	2,400
		U. S. Geologist	4,500
Entomologist	2,000	Register of Treasury	4,000
Superintendent of grounds	2,000	Principal Examiner of Patents	2,400
Botanist	1,800	Architect of the Treasury	4,500
Microscopist	1,800	Architect of the Capitol	4,500
Disbursing clerk	1,800	Disbursing clerk Post-Office Department	2,100
		Chief Division of the Treasury	2,000
Superintendent seed division	1,800	35 clerks Treasury Department, each	2,000

These figures show that the chemist of the department receives less than do a score or more of mere clerks in other branches of the government. Other disparities are equally apparent. I must believe, then, that when called to the attention of Congress the fact will be recog-

nized that a general increase of salaries commensurate with the work performed is not a need only, but an act of pure justice.

Bad crops in Great Britain and other European states and the disturbed condition of the Russian people, with a comparative failure of their wheat crop, have enabled us to obtain fair market priees for the immense amount of surplus food we have harvested for the past few years, and have brought returns for our agricultural labor that we should not expect or hope will continue uninterruptedly. That a change may come at any day is a matter for serious consideration not only for our statesmen, but for all classes and conditions of our people.

Our fertile virgin soil, its cheap cultivation, its accessibility, and the unprecedented rapidity and cheapness with which farm produce of all kinds may be moved, all go to stimulate production in the highest degree. That the demand for our products will keep pace with the rapid increase of production, that it will even equal the demand for the past three years, should not be hoped for, much less expected. A single good crop in Europe would undoubtedly depress our markets so as to greatly lessen the margin of profits to the producer, thus endangering the present era of prosperity, and bringing instead wide-spread disaster, not only to the farmers, but to the manufacturers, the merchants, the public carriers, and all other classes of people.

It is important, then, that no means be omitted to insure and immediately enlarge the range of our markets, whether with the Southern American States, with Mexico, or with Asia, to encourage by all means greater diversity of crops and to discourage any sudden large increase in productions of any kind, but particularly over-production of agricultural staples.

European statisticians tell us that every thirty years there are about the same number of good and bad crop years, and that having had of late their average of bad years, these countries may now hope for a number of good years to follow. This is altogether probable, and the American farmer should prepare, as far as possible, to meet a market for food products that may be glutted with the one-half of our offering.

In conclusion it affords me great pleasure to report that during the year the officers and employés of this department have performed the duties that devolved upon them in an entirely creditable manner.

I have the honor to be, respectfully, your obedient servant,

WM. G. LE DUC,
Commissioner of Agriculture.

REPORT OF THE CHEMIST.

SIR: I have the honor to present the following report of the work done by the Chemical Division from May 17, 1880, to March 31, 1881.

Much the greater part of this work has been done in connection with the investigation of the juices of the stalks of various varieties of sorghum and corn. This large amount of analytical work has already been published as part of "Special Report No. 33." It is again presented for republication in the Annual Report for 1880, in order that it may be preserved in more permanent form as a contribution to the chemistry of these sugar-producing plants.

The following is a partial summary of the analyses that have been made:

1. Three thousand six hundred and five analyses of sorghum and corn juices and sirups.
2. Four analyses beet sugars and sirups.
3. Six analyses waste products from corn and sorghum sugar work.
4. Four analyses of ash from sorghum canes and juices.
5. One analysis of soil on which the corn and sorghum were grown.
6. Five analyses of fertilizers used on corn and sorghum.
7. One hundred and thirty-five analyses of American grasses.
8. Fourteen analyses of food materials.
9. Twelve analyses of mineral and potable waters.
10. Eighteen analyses marls and fertilizers.
11. One hundred and eighty analyses native wines.
12. Two analyses cinchona barks.
13. Three analyses of indigenous medicinal plants or plant products.
14. Ten analyses of minerals.
15. Two analyses American sumach.
16. Six analyses veterinary medicines, &c.

In addition to the above-mentioned analyses, this division has made a large number of partial quantitative or qualitative examinations of various substances, in order to give advice in answer to many questions of agricultural interest. To properly reply to the inquiries daily received has required a large part of my own time.

A considerable amount of work has been done in the perfection of analytical methods, and the establishment of the limits of probable error.

The object of this work has been to ascertain as many facts as possible in relation to the development and actual composition of the stalks and juices of the different varieties of sorghum and corn which can be successfully grown in the United States. It is fully believed that a careful study of the life history of these plants will do more than any one thing, aside from the actual separation of the sugar itself, to demonstrate the practicability of sugar production from sorghum, and probably from cornstalks.

Further, it is certain that careful experiments in the laboratory are very valuable in directing and modifying the actual processes of manufacture; the more intimate our knowledge of the juice itself the more prospect is there for success in manufacturing operations.

The general drift of the work during the past season has been in the following direction, viz: the demonstration of the period at which the juice of each particular variety of sorghum or corn contained the most crystallizable sugar which could be profitably separated.

Incidentally many questions have presented themselves which have a more or less direct bearing on the utilization of the, at present, waste products, such as the skimmings, bagasse, the residual molasses, and the seeds and leaves. The perfection and simplification of analytical methods has been another class of work which has engaged considerable attention, and has been rewarded with satisfactory results.

For the discussion of these and numerous other questions which have arisen in this connection, we beg to refer to the following pages.

ORIGINAL DATA.

In order that the work done this year may be permanently recorded in such shape as to be of future value, it has seemed best to publish the original figures exactly in the form in which they were copied from the laboratory note-books of the various assistants engaged in the work. All averages which appear later were drawn from these results, and no figures have been added or withheld.

These plates represent 3,601 analyses of 38 varieties of sorghum, 11 varieties of cornstalks, and a few outside samples of sugar and sirup; nearly all of these analyses were made between July 12 and December 17, 1880.

For the purpose of facilitating comparison, the canes have been arranged in the order shown by the following list, and this order, and the numbers corresponding with each cane, have not been departed from.

List of names and immediate sources of the seed of the different varieties of Sorghum and Maize experimented upon by this department during 1880.

SORGHUM.

Reference number.	Name of variety.	Source of seed.
1	Early Amber	D. Smith, Arlington, Va.
2	do	Plant Seed Company, Saint Louis, Mo.
3	Early Golden	A. B. Swain, Elysian, Minn.
4	Golden Sirup	W. H. Lytle, Yellow Springs, Ohio.
5	White Liberian	D. Smith, Arlington, Va.
6	Early Amber	S. E. Evans, Monroe, Kans.
7	Black Top	D. W. Aiken, Cokesbury, S. C.
8	African	W. E. Parks, Carlisle, Ky.
9	White Mammoth	Amos Carpenter, Carpenter's Store P. O., Mo.
10	Oomseeana	Blymyer & Co., Cincinnati, Ohio.
11	Regular Sorgho	Do.
12	Hybrid	E. Link, Greenville, Tenn.
13	Sugar Cane	J. W. Barger, Lovilia, Iowa.
14	Oomseeana	D. W. Aiken, Cokesbury, S. C.
15	Neeazana	W. H. Lytle, Yellow Springs, Ohio.
16	Goose Neck	P. P. Ramsey, Belgrade, Mo.
17	Early Orange	I. A. Hedges, Saint Louis, Mo.
18	Neeazana	Blymyer & Co., Cincinnati, Ohio.
19	New Variety	E. Link, Greenville, Tenn.
20	Chinese	D. Smith, Arlington, Va.
21	Wolf Tail	E. Link, Greenville, Tenn.
22	Gray Top	H. C. Sealey, Columbia, Tenn.
23	Liberian	Blymyer & Co., Cincinnati, Ohio.
24	do	W. H. Lytle, Yellow Springs, Ohio.
25	Oomseeana	W. I. Mayes & Co., Sweet Water, Tenn.
26	Sumac	W. Pope, ——, Ala.
27	Mastodon	D. W. Aiken, Cokesbury, S. C.
28	Imphee	Do.
29	New Variety	J. W. H. Sallo, Strafford, Mo.
30	Sumac	J. H. Wighton, Mount Olive, Ala.
31	Honduras	Arsenal, Washington, D. C.
32	Honey Cane	J. H. Clark, Pleasant Hill, La.
33	Sprangle Top	W. Pope, ——, Ala.
34	Honduras	E. Link, Greenville, Tenn.
35	Honey Top or Texas Cane	——, Brussels, Mo.
36	Honduras	L. Brande, Mayersville, Tex.
37	Sugar Cane	C. E. Miller, Effingham, Ill.
38	Hybrid	J. C. Moore, San Diego, Cal

List of names and immediate sources of the seed of the different varieties of Sorghum and Maize experimented upon by this department during 1881—Continued.

MAIZE, ETC.

Reference number.	Name of variety.	Source of seed.
39	Rice or Egyptian Corn	Root & Hollingsworth, Kinsley Court-House, Kans.
40	Doura Corn	——, S. C.
41	Stowell's Evergreen	W. R. Shelmire, Chester, Pa.
42	Egyptian Sugar	Do.
43	Lindsay's Horse Tooth	Lindsay, Portsmouth, Va.
44	White Flat Dent	Market, Washington, D. C.
45	Improved Prolific	J. M. Thorburn, New York, N. Y.
46	White Dent	T. L. Jones, Warrenton, Va.
47	Sanford	F. B. Hathaway, Milton, Vt.
48	Mammoth Dent	M. J. Varney, North Collins, N. Y.
49	Early Minnesota Dent	Do.

DISTINGUISHING MARKS OF STAGES OF GROWTH OR DEVELOPMENT USED IN THE ACCOMPANYING WORK.

In order to make as close a record as possible of the development of the plants at the time they were taken from the field for examination, a series of numbers and letters were made use of, which indicated the stages of advancement in growth. Determination of the stages after No. 14 was more difficult than that of the preceding ones, and depended upon the increasing hardness of the seed. These signs and their significations are as follows:

SORGHUM.

Stage.	Development of plant.
E	About one week before opening of panicle.
F	Immediately before opening of panicle.
1	Panicle just appearing.
2	Panicle two-thirds out.
3	Panicle entirely out; no stem above upper leaf.
4	Panicle beginning to bloom on top.
5	Flowers all out; stamens beginning to drop.
6	Seed well set.
7	Seed entering the milk state.
8	Seed becoming doughy.
9	Seed doughy, becoming dry.
10	Seed almost dry, easily crushed.
11	Seed dry, easily split.
12	Seed split with difficulty.
13	Seed split with more difficulty.
14	Seed split with still more difficulty.
15	Seed harder.
16	Seed still harder.
17	Seed still harder.
18	Seed still harder.

MAIZE.

E	Ear two weeks younger than roasting condition.
F	Ear one week younger than roasting condition.
1	Ear ready for roasting.
2	One week after roasting ears were plucked.
3	Two weeks after roasting ears were plucked.
4	Three weeks after roasting ears were plucked.
5	Four weeks after roasting ears were plucked.
6	Five weeks after roasting ears were plucked.
7	Six weeks after roasting ears were plucked.
8	Seven weeks after roasting ears were plucked.
X	Ears still remaining on stalk, ripe.
Y	Ears still remaining on stalk, more ripe.
Z	Ears still remaining on stalk, still more ripe.

SYNOPTICAL TABLE OF THE VARIETIES OF SORGHUM CULTIVATED AT THE DEPARTMENT OF AGRICULTURE DURING THE SUMMER OF 1880.

The following table cannot claim any great degree of botanical accuracy, as it has been worked out from single dry heads and without a careful comparison of the varieties growing in the field. It is believed, however, that it will be of great assistance in aiding the practical farmer to distinguish, with the aid of the illustrations, whatever variety he may have on hand.

The large number of hybrids which have been produced between the African or "Imphee," and the Chinese or "Honduras" species, render it very difficult to characterize them by mere verbal descriptions; but they can be recognized as a class by their uniting the characteristics of both species.

THE RIPE GRAIN.

I. Longer than the glumes (husks).
(*a.*) Panicle or head dense.
1. Glumes black.
α Inconspicuous.
Liberian or *Imphee.*
Head short, 6 to 7 inches long, dense, cylindrical, obtuse; general color dark brown.
Glumes small, obtuse, black shining; outer one hairy on the margin.
Seed smallest of all varieties, round, obtuse, tapering to the base; hilum or point of attachment of a lighter color and prominent.
β. Conspicuous.
Seeds brown; effect of head black. (Grain at times hardly longer than the glumes.)
Oomseeana.
Head slender, erect, 8 to 9 inches long; branches closely appressed, but not dense.
Glumes black, pointed; outer one keeled smooth and open.
Seed deep brown, and visible between the open glumes; plane convex, acute at both ends.
Black Top.
Head larger and broader than the preceding, blacker and more dense; seed lighter.
Bear Tail.
Denser head and longer glumes than in preceding, resembling in some respects a compacted Early Amber.
Iowa Red Top.
An Oomseeana cane, with large, prominent seeds and smaller glumes.
Seeds white.
White Mammoth.
Head very dense, expanding toward the flattened top.
Glumes shining black, prominent.
Seed white, large, flattened; hilum inconspicuous.
2. Glumes light-red brown.
Seed white.
White African.
Head. (No specimen at hand.)
Glumes large, light-red, shining.
Seed large, white.
Seed yellowish brown.
Neeazana.
Head 5 to 8 inches long, dense, cylindrical.
Glumes pointed, somewhat hairy; outer one gray; inner one black, smaller, and inconspicuous.
Seed long, flat; hilum inconspicuous.
Synon. White Imphee, '65 report, Early Orange.
New Variety (Salle), similar to Neeazana, but both glumes are at times light colored and hairy.

I. Longer than the glumes (husks)—Continued.
(*a.*) Panicle or head dense.
2. Glumes light-red brown.
Wolf Tail.
Head 9 to 10 inches long, slender, dense.
Glumes almost white, shining, somewhat downy.
Seed shorter than in Neeazana, long, round; hilum slightly flattened.
Gray Top.
Head similar to Neeazana, but glumes brown, shining, obtuse, short.
Seed short, large, prominent, round; hilum only slightly flattened; distinguished by its brown glumes and the prominence of the large round seeds in the head.
3. Glumes gray.
Rice, or Egyptian Corn.
Head heavy, bending the culm, dense, obtuse, cylindrical.
Glumes gray, prominent, wooly, persistent.
Seed large, flat, white, round in outline, width greater than the length; prominent in the head, and easily shaken out.
(*b.*) Panicle not dense.
Glumes black.
Regular Sorgho.
Head loose, 10 to 12 inches long.
Glumes black, shining, open, displaying the seeds.
Seeds large, flat, obtuse.
Hybrid Sorghum.
Hybrid of E. Link.
Oomseeana of Blymyer.
New Variety of E. Link.
These are hybrids of the Liberian or Imphee varieties, with the Honduras or Chinese varieties, and bear the characteristics of both races. Here, also, might be mentioned—
African of Parks, of Kentucky.
Hybrid of Moore.
II. Equal to the glumes.
(*a.*) Glumes closed or nearly so.
Red and palet awned.
Honduras or True Chinese.
Head, 1 foot long, thin, loose, spreading, nodding.
Glumes reddish brown, shining, somewhat hairy, acute at both ends; inner one keeled.
Seed long, very acute at the base, obtuse at the apex; plane convex; hilum conspicuous, with a prominence at the base and a round mark at the upper edge.
Synon. Mastodon, Honey Cane, Sprangle Top, Honey Top. These all vary slightly so as to be distinguished in the field, but not, however, by description.
Deep chocolate palet awned.
Hybrid of Wallis, Collin County, Texas.
Similar to the Honduras, except in the deep brown glumes and more compact head, showing its Imphee affinities.
(*b.*) Glumes open.
Under this head might be sought Regular Sorgho and Black Top, classed as having the grain longer than the glumes.
III. Shorter than the glumes.
(*a.*) Glumes black.
Culm erect.
Early Amber.
Head slender, erect; branches appressed, pointed, 9 to 10 inches long.
Glumes large, smooth, shining, acute at both ends, concealing the seed or open, flattened on both sides.
Seeds long, obtuse, light colored; hilum large, with a prominence in the center.
Synon. Early Golden, Golden Sirup.
Culm erect, or often bent with heavy heads.
Goose Neck.
Head inverted on the bent culm; somewhat loose, 8 inches long.
Glumes shining, downy at the tips, flattened.
Seeds smaller than Amber, long, acute at the base, obtuse at the apex, somewhat flattened.

III. Shorter than the glumes—Continued.

(*b.*) Glumes purplish.

White Liberian.

Head slender, erect, or goose-necked; branches appressed, pointed.

Glumes large, smooth, shining, acute at both ends, often not covering the seed. Infertile ones often very prominent and purplish-gray.

Seed large, long, and similar to the Amber, but hilum more prominent.

Synon. Sugar Cane (Barger).

THE ANALYTICAL PROCESSES FOR THE EXAMINATION OF THE CANES.

One or more stalks of the variety of sorghum to be examined were selected in the experimental field, and after recording the stage of development and general appearance of the canes, a number was affixed by which they could be distinguished during the remainder of the examination. After being cut and brought to the laboratory, the length of the stalk from butt to the extremity of the head, its entire weight and diameter at the butt were taken. It was then stripped and topped, as in the usual way of preparation for the mill, and again weighed. The "stripped stalk" was then expressed in a three-roll mill, and the juice collected in a weighed flask and weighed to determine "per cent. of juice" in the stripped stalk. The specific gravity was determined with a piknometer, after an interval of an hour to allow the escape of air bubbles and the subsidence of suspended starch. For the determination of the "total solids" in the juice 2$^{cm^3}$ were accurately measured into a weighed porcelain dish 6 to 7$^{cm.}$ wide and 1.5 to 2$^{cm.}$ deep, the bottom of which was covered with coarse sand to a depth of .75$^{cm.}$ to insure complete desiccation. After twelve to fourteen hours' drying at 85° to 90° C., there was no further loss of water. The weight of the residue in grams divided by twice the specific gravity gave the per cent. of "total solids."

For the determination of *glucose and sucrose*, 100$^{cm^3}$ of the juice were taken and defecated by the addition of 25$^{cm^3}$ of solution of basic acetate of lead and water. The filtrate from the lead precipitate, which was perfectly clear, was in many instances polarized and then devoted to the methods of volumetric analysis. Owing to the degree of dilution, every 10$^{cm^3}$ of filtrate represented 8$^{cm^3}$ of juice.

For the determination of glucose 10$^{cm^3}$ of the filtrate were taken; for sucrose, 5$^{cm^3}$. The portion for glucose was diluted with about 50 to 75$^{cm^3}$ of water and about the same amount of Fehling's solution added. The porcelain dish containing the whole was placed upon a water bath kept at such a temperature by steam that the liquid in the dish rose to about 75° C., but no higher. After an interval of thirty minutes the dish was removed and allowed to cool. The portion for sucrose was diluted with about 100$^{cm^3}$ of water, 5$^{cm^3}$ of hydrochloric acid (sp. gr. 1.05) added, and the mixture heated in a porcelain dish on a steam bath for a half hour, the temperature not rising above 90° C. The inversion being complete, an excess of Fehling's solution was added, depending in amount on the maturity of the cane; and the liquid allowed to remain thirty minutes longer on the bath, after which it was removed. When the suboxide of copper had completely settled, in the case of both sucrose and glucose, the supernatant liquid was decanted into a beaker placed in front of each dish, and hot water was poured over the suboxide. This process was repeated, pouring the first liquid decanted into a second beaker, and so on until it could be poured away free from any oxide, and the original dish was nearly free from alkali. All the wash waters were then passed in order through a filter,

taking care not to bring more of the suboxide upon the paper than was necessary. The suboxide on the filter and in the beakers was dissolved in an acid solution of ferric sulphate, free from nitric acid and ferrous salt, or more conveniently in an acid solution of ammonia ferric alum (which is more easily obtained free from impurities), and poured upon the suboxide in the original dish. All the copper suboxide being dissolved, it is brought into a liter flask, diluted with water to 500cm³. and acidified strongly with sulphuric acid. It is then ready to be titrated in the usual manner for the amount of reduced iron, the number of cm³. of permanganate used giving easily the weight of glucose represented by the suboxide of copper, as shown in our report for 1879, p. 66.

In order to determine what errors there may have been in estimating glucose and sucrose by this method, the following experiments were carried out. Every portion of Fehling solution used was heated by itself in the steam bath for an hour to determine if it remained unreduced in absence of sugar. In all cases it was quite unchanged. Several solutions of dry granulated sugar containing about .10 per cent. of impurities were made of such a strength that every 5cm³. contained .5000 gram of pure sucrose, or, on inversion, .5263 of invert sugar.

Of solution No. 1, four portions were measured out of 5cm³. each and submitted to the usual course of analyses, with the following result:

Experiment.	Titration.	Glucose found.	Glucose used.	Per cent. found.
No. 1	104.2	.5210	.5263	98.99
No. 2	103.4	.5170	.5263	98.24
No. 3	104.4	.5220	.5263	99.18
No. 4	104.5	.5225	.5263	99.28
Average				98.93

The specific gravity was found by the piknometer to be 1.034. The solution contained, therefore, 9.67 per cent. of sugar. By titration we find 9.57 per cent. of sugar, and polarization of the solution gave 9.63 per cent. of sucrose.

Of the solution No. 2, nine portions were taken of 5cm³. each, to six of which (Nos. 1–6) 5cm³. of the usual dilute acid were added, and to the remaining three, 10cm³.; otherwise the usual course of analysis was pursued. The entire lot was carried through simultaneously on the same steam bath. The results were as follows:

Experiment.	Cm³. of permanganate.	Glucose found.	Per cent of original.	Per cent. sucrose in solution.
No. 1	104.5	.5225	99.28	9.60
No. 2	105.3	.5265	100.10	9.67
No. 3	106.6	.5330	101.26	9.79
No. 4	108.3	.5415	102.88	9.95
No. 5	107.4	.5370	102.02	9.86
No. 6	108.1	.5405	102.70	9.93
No. 7	104.6	.5230	99.38	9.61
No. 8	104.4	.5220	99.18	9.59
No. 9	105.2	.5260	99.94	9.66
Average			100.74	9.74

The specific gravity was found to be 1.034 and the per cent. of sugar in the solution was therefore: By calculation, 9.67; by titration, 9.74. An estimation of total solids gave 9.70 per cent. The addition of the larger amount of acid apparently had the effect of lowering the per cent. of sucrose found. In no case was the error in the final result sufficiently large to be of account in work on such a large scale.

Fifteen portions of 5^{cm^3} each were taken from solution No. 3. Its specific gravity was 1.035, and the per cent. of sucrose 9.66. Submitted to analysis in the usual way the results were:

Experiment.	C^{m^3}. of permanganate at .005 glucose.	Glucose found.	Sucrose found.	Per cent. of sucrose.
No. 1	107.0	.5350	.5082	9.82
No. 2	108.0	.5400	.5130	9.91
No. 3	106.0	.5300	.5035	9.73
No. 4	106.0	.5300	.5035	9.73
No. 5	107.0	.5350	.5082	9.82
No. 6	106.0	.5300	.5035	9.73
No. 7	108.7	.5435	.5163	9.98
No. 8	106.8	.5340	.5073	9.80
No. 9	106.3	.5315	.5049	9.76
No. 10	106.5	.5325	.5059	9.78
No. 11	106.8	.5340	.5073	9.80
No. 12	106.3	.5315	.5049	9.76
No. 13	106.0	.5300	.5035	9.73
No. 14	104.9	.5245	.4983	9.63
No. 15	105.3	.5265	.5002	9.66
Average				9.77

By calculation	9.66
By titration	9.77

The results of thirty determinations may be stated as follows:

	Per cent.
Sugar solution containing	9.67
No. 1. Four determinations, by titration (average)	9.57
No. 2. Nine determinations, by titration (average)	9.74
No. 3. Fifteen determinations, by titration (average)	9.77
No. 1. One polarization	9.63
No. 2. One determination of total solids	9.70
The lowest result was	9.50
The highest result was	9.98

It may be assumed, therefore, that *the greatest error is not more than minus one-tenth or plus three-tenths of one per cent.*, which, in the work under hand, cannot be considered excessive.

In order to have a check on the process when applied to juices as well as pure sugar solutions, polarizations were made in a large number of cases. Where the percentage of glucose or of invert sugar was small, the agreement was close; but in the presence of these sugars the results naturally fell below those by titration, the latter being more correct.

The following table gives a series of observations:

Corn juices.				Sorghum juices.							
Number of analysis.	Sucrose by polariscope.	Sucrose by titration.	Glucose.	Number of analysis.	Sucrose by polariscope.	Sucrose by titration.	Glucose.	Number of analysis.	Sucrose by polariscope.	Sucrose by titration.	Glucose.
1937	10.60	10.41	....	2006	13.56	13.61	2.16	2039	12.66	12.80	2.50
38	3.62	3.58	....	8	14.24	14.48	1.35	40	12.94	13.21	2.09
39	6.74	6.64	....	9	14.86	14.92	.84	41	12.28	12.86	2.44
41	6.81	6.72	....	*10	14.76	15.49	.59	42	12.93	13.29	2.44
42	7.03	7.09	....	14	10.84	10.56	1.44	43	12.86	12.81	1.23
43	7.48	7.62	....	15	10.20	10.00	1.41	*44	13.25	11.65	1.76
44	3.02	3.16	....	16	10.20	10.61	1.47	50	12.96	13.21	1.15
45	11.54	11.72	....	18	10.73	11.22	1.64	51	13.65	14.09	1.75
*46	4.91	5.85	....	*22	4.48	6.39	2.16	52	13.49	13.37	1.96
*47	1.56	2.71	....	24	12.88	13.00	1.67	*53	12.51	14.01	2.19
*1948	3.28	1.62	....	2027	11.96	11.76	1.95	2054	12.93	13.13	2.16
*52	11.80	8.70	....	28	14.21	13.62	1.74	55	12.43	12.60	2.39
53	9.93	9.81	....	29	13.32	12.79	2.13	56	12.08	11.55	2.39
54	9.48	9.11	....	31	13.20	13.10	1.23	57	12.80	13.02	2.07
55	8.75	8.56	....	32	11.36	11.74	1.27	58	12.40	12.95	2.23
56	6.04	5.89	....	33	13.36	13.54	.97	59	13.05	13.35	1.97
57	9.46	9.49	....	34	13.90	14.05	1.09	60	12.58	12.81	2.24
58	7.83	7.29	....	35	12.13	12.09	1.92	61	12.60	13.60	2.06
79	6.41	6.74	4.57	36	12.56	12.52	2.18	62	12.13	12.13	1.86
80	5.84	6.19	4.56	37	12.46	12.77	2.01	64	11.98	12.72	2.59
81	6.66	5.97	1.92	38	12.55	12.91	2.34	65	13.26	13.88	1.90

In this table, which contains the polarization of all the juices in a consecutive series which were clear enough for the purpose after defecation, the agreement is satisfactory in all but a few instances, marked with an asterisk, and these cases are more easily explained by errors in the polariscope work than in titration. The results which are given are only a few out of several hundred similar ones which show an equally close agreement.

The conclusions which may be drawn from our experiments are that, in experienced hands, the relative results are to be entirely relied upon, and, when the conditions which have been detailed are followed, the absolute results are also satisfactory.

EXPLANATION OF THE TABLES SHOWING THE AVERAGE COMPOSITION, ETC., FOR EACH VARIETY OF SORGHUM IN EACH STAGE OF ITS GROWTH.

The following tables (tables 51 to 87) are of interest and value, for the reason that they present, in condensed form, the life history of each variety of sorghum.

An examination of these figures reveals the following facts: In the earlier stages in the growth of each plant the amount of crystallizable sugar (sucrose) is small; but, as the plant matures, the sucrose rapidly increases until it equals from 12 to 16 per cent. of the juice. The "solids not sugar" in the juice also increase from the first, but very much less rapidly than does the crystallizable sugar; at the same time the uncrystallizable sugar (glucose) steadily diminishes, so that the purity of the juice (shown in the column marked "exponent") increases constantly until the cane is ready to be worked.

These facts, and the inferences to be drawn from them, will be more fully discussed in connection with the general averages deduced from these figures. (See table 88.)

ANALYSES OF JUICES FROM SORGHUM.

TABLE No. 1.—EARLY AMBER. D. SMITH, ARLINGTON, VA.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	In.	Lbs.	Lbs.	Pr. ct.		Pr. ct.	Pr. ct.	Pr. ct.	
July 12	1	1	2	6.5	0.8	......	1.45	36.27	1.028	4.71	.60	.99	
13	2	8	2	7.5	.6	......	1.47	52.30	1.041	3.77	2.25	1.72	
15	3	13	2	7.5	.6	......	1.23	46.99	1.040	3.66	5.53	.91	
16	4	21	2	8.5	.7	2.37	1.74	54.73	1.037	3.62	4.91	.95	
17	5	24	2	8.7	.8	2.74	2.24	43.97	1.049	3.10	7.81	1.83	
20	6	49	2	8.6	.7	2.57	2.04	44.13	1.057	2.78	9.55	2.03	
21	7	71	2	8.6	.6	2.64	2.26	43.96	1.063	2.30	11.03	2.80	
22	7	116	2	8.2	.6	2.26	2.02	54.77	1.053	2.21	8.16	2.91	Light green, starchy.
23	8	117	1	8.6	.7	1.46	1.22	61.83	1.063	2.87	10.74	2.15	Do.
26	10	163	1	9.0	.7	1.45	1.13	61.36	1.058	2.43	10.65	1.78	Do.
27	10	203	1	8.4	.7	1.21	.99	64.73	1.067	1.80	12.65	2.79	Do.
28	10	237	1	8.7	.8	1.69	1.43	65.06	1.066	2.23	11.75	2.20	Do.
29	10	264	1	9.4	.6	1.37	1.14	62.10	1.073	1.58	10.77	......	Do.
31	11	307	1	8.9	.6	1.23	1.05	58.94	1.076	1.46	13.68	3.68	Do.
Aug. 2	12	342	1	9.0	.8	1.50	1.34	60.02	1.078	1.32	14.80	3.02	Do.
9	11	559	1	3.7	.8	1.59	1.23	64.64	1.070	1.23	13.80	2.40	Do.
3	11	405	1	8.8	.7	1.33	1.13	65.63	1.071	1.53	13.63	2.86	Do.
3	11	406	1	8.8	.6	1.09	.92	61.98	1.077	1.51	13.45	4.21	Do.
3	11	407	1	8.0	.8	1.29	1.10	62.80	1.072	1.49	13.98	2.53	Do.
3	11	408	1	9.1	.8	1.43	1.19	63.93	1.073	1.48	14.23	2.65	Do.
6	12	480	1	8.5	.9	1.41	1.16	59.96	1.074	1.21	14.63	3.57	Do.
6	12	490	1	8.5	1.1	1.50	1.20	61.43	1.074	1.22	14.58	3.56	Do.
6	12	491	1	8.8	1.0	1.31	1.11	64.95	1.074	1.41	14.12	3.69	Do.
6	12	492	1	8.5	1.0	1.52	1.12	65.00	1.073	1.47	13.93	3.75	Do.
July 29	10	265	2	9.2	.7	2.22	2.75	64.50	1.067	2.17	12.33	Lost.	Do.
29	10	266	2	9.2	.7	2.40	2.06	71.08	1.070	2.23	12.37	Lost.	Do.
29	10	267	2	8.8	.7	2.48	2.07	63.98	1.073	1.89	13.36	Lost.	Do.
29	10	268	2	8.5	.6	2.35	1.07	65.47	1.073	1.99	12.89	Lost.	Do.
Aug. 12	12	679	1	9.2	.7	1.76	1.23	......	1.074	1.08	14.07	2.40	Dark green, starchy.
12	12	680	1	9.0	.7	1.21	.87	65.82	1.065	1.41	12.24	1.56	Do.
12	12	681	1	8.6	.8	1.27	.95	65.82	1.067	1.23	12.70	2.94	Do.
12	12	682	1	9.0	.8	1.63	1.21	60.00	1.072	.97	14.30	2.26	Do.
16	13	809	1	9.5	.6	1.73	1.32	62.48	1.069	1.12	12.83	2.61	Do.
16	13	810	1	8.8	.6	1.31	.98	42.50	1.065	1.57	11.89	2.17	Do.
16	13	811	1	9.0	.8	1.69	1.25	59.22	1.073	1.21	14.07	2.24	Do.
16	13	812	1	8.8	.7	1.61	1.16	57.67	1.072	.99	13.92	2.44	Do.
19	13	981	1	8.2	.8	1.51	1.22	58.63	1.070	1.30	12.86	3.41	Do.
19	13	982	1	9.2	.8	1.45	1.21	57.66	1.065	1.17	11.97	3.24	Do.
19	13	983	1	8.8	.8	1.52	1.27	64.11	1.070	1.33	11.97	4.41	Do.
19	12	984	1	8.0	.7	1.52	1.17	56.39	1.078	.94	14.61	......	Do.
21	15	1085	2	8.7	.8	2.78	1.96	60.33	1.065	1.43	11.84	2.93	Very dark green.
21	15	1086	2	8.7	.8	2.78	1.92	42.70	1.063	1.78	11.61	2.46	Dark reddish brown.
26	13	1256	1	9.1	.8	1.53	.91	60.86	1.071	.93	13.58	2.58	Dark brown, starchy.
26	13	1257	1	9.5	1.0	1.97	1.22	63.25	1.071	1.11	13.53	2.63	Do.
26	13	1258	1	9.3	.9	1.48	1.01	64.78	1.059	1.57	10.28	2.50	Do.
26	12	1259	1	9.0	.9	1.67	1.08	59.55	1.078	.79	14.67	3.42	Dark green, starchy.
30	14	1433	1	8.4	.8	1.42	.91	33.95	1.069	1.20	12.70	3.50	Dark brown, starchy.
30	14	1434	1	8.7	.8	1.47	.75	61.55	1.060	1.18	12.77	3.82	Do.
30	14	1435	1	9.0	.8	1.52	.91	57.26	1.068	1.36	12.34	4.18	Do.
30	14	1436	1	8.1	.8	1.61	.83	52.77	1.065	.63	12.39	3.25	Dark green, starchy.
Sept. 3	14	1608	1	9.0	.9	1.85	1.03	52.81	1.067	.86	13.23	2.44	Do.
3	14	1609	1	9.4	.7	1.46	.97	61.36	1.062	1.31	11.26	3.00	Dark brown, starchy.
3	14	1610	1	9.0	.8	1.16	.78	55.21	1.069	1.36	12.59	3.59	Do.
3	14	1611	1	8.7	.7	1.43	.79	60.77	1.068	1.03	13.05	2.94	Do.
8	15	1827	1	8.2	.7	1.19	.81	61.74	1.065	1.22	10.90	4.08	Do.
8	16	1828	1	9.0	.7	1.25	.77	64.20	1.056	2.01	9.56	2.78	Do.
8	15	1829	1	9.1	.7	1.49	.98	55.24	1.069	1.29	13.01	2.92	Do.
8	15	1830	1	9.0	.7	1.35	.86	59.64	1.058	1.35	9.09	4.35	Do.
10	15	1914	1	7.5	.8	1.59	.94	60.11	1.057	1.39	10.04	1.05	Dark green, starchy.
15	15	2014	1	8.5	.8	1.80	1.10	60.12	1.065	1.44	10.56	3.63	Dark brown, starchy.
15	15	2015	1	8.6	.8	1.17	.75	54.97	1.063	1.41	10.00	4.39	Do.
15	15	2016	1	8.9	.8	1.20	.80	56.64	1.063	1.47	10.61	3.91	Do.
15	15	2017	1	8.5	.8	1.21	.74	57.98	1.062	1.79	10.15	3.31	Do.
18	14	2134	1	9.1	.8	1.76	1.29	57.24	1.070	.89	12.11	4.62	Dark green, starchy.
18	15	2135	1	9.6	.8	1.45	1.04	55.09	1.060	1.77	8.96	4.27	Dark brown, starchy.
18	15	2136	2	8.5	1.0	3.52	.93	52.00	1.062	1.62	10.20	4.00	Do.
18	15	2137	1	8.0	.9	1.33	.88	55.86	1.068	1.29	12.12	3.12	Do.
24	16	2367	1	9.1	.8	1.92	1.17	57.51	1.064	1.41	11.87	3.21	Do.
24	16	2368	1	9.0	.8	1.46	.76	58.35	1.062	1.78	10.95	3.31	Do.
24	16	2369	1	8.6	.8	1.42	.82	60.48	1.064	2.16	10.15	3.42	Do.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Sept. 24	16	2370	1	9.4	0.8	1.31	.93	57.57	1.049	1.64	7.85	3.57	Dark brown, starchy.
27	16	2530	1	8.8	.8	1.31	.88	46.75	1.062	1.32	11.29	2.41	Do.
27	16	2531	1	9.3	.8	1.06	.72	64.69	1.069	1.13	13.05	2.46	Do.
27	16	2532	1	8.5	.8	1.36	.84	60.52	1.067	1.45	12.33	2.44	Do.
27	14	2533	1	7.9	.8	1.25	.85	59.47	1.071	.95	13.78	2.54	Dark green, starchy.
30	16*	2681	1	6.0	.8	1.43	1.03	59.44	1.058	1.17	10.31	2.74	Dark brown, starchy.
Oct. 2	16	2727	1	8.6	.8	1.41	.92	60.57	1.067	1.69	10.97	4.02	Do.
6	17	2785	1	9.2	.8	1.34	.84	58.42	1.071	1.81	11.81	3.99	Dark olive, starchy.
8	17	2871	1	8.8	.7	1.32	.70	53.79	1.076	1.34	13.70	3.75	Red.
12	16	2941	2	9.0	.8	2.42	1.71	68.98	1.064	1.26	12.24	2.59	Light green, starchy.
14	17	2987	1	8.9	.8	1.23	.80	62.19	1.081	1.17	14.60	3.52	Dirty green.
15	17	3029	1	9.4	.8	1.58	.88	59.70	1.075	1.28	13.72	4.02	Dark olive.
17	18	3085	1	8.5	.9	1.57	.96	60.00	1.069	1.34	12.50	3.97	Do.
19	18	3069	1	8.8	.9	1.50	.97	64.71	1.061	1.56	10.27	3.96	Do.
21	18	3144	1	8.5	.7	1.23	.71	56.97	1.062	1.88	10.17	5.28	Do.
22	18	3188	1	8.4	.8	.90	.63	56.94	1.064	1.77	10.93	3.98	Do.
26	18†	3252	1	7.0	.8	1.01	.82	55.38	1.069	1.61	12.94	3.04	Dark green.
28	17	3297	1	8.4	.8	1.34	.92	55.26	1.074	1.54	13.24	4.40	Dark brown.
29	18	3328	1	6.2	.8	.89	.65	58.64	1.052	1.86	7.49	4.96	Do.
Nov. 2	17‡	3373	1	10.5	1.1	......	.95	50.23	1.082	1.16	15.25	3.32	Dark straw.
6	17	3441	1	8.0	.8	1.09	.77	61.21	1.074	1.46	13.06	2.82	Dark olive.
8	18	3456	1	8.0	.7	.83	.68	54.55	1.066	1.52	11.18	2.98	Do.
8	18	3427	1	9.0	.8	1.17	.99	54.34	1.055	2.19	8.41	3.48	Do.
13	18	3522	2	8.5	.6	1.23	.91	55.58	1.069	2.25	10.64	4.56	Do.

*Topped August 28. †Topped. ‡Stripped and topped.

TABLE NO. 2.—EARLY AMBER. PLANT SEED COMPANY, SAINT LOUIS, MO.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
July 12	1	2	2	7.5	0.6	......	1.38	62.78	1.026	4.04	.98	.91	
15	2	14	2	8.5	.6	......	1.78	30.70	1.035	3.96	3.47	1.27	
21	2	82	4	6.6	.5	2.92	2.34	55.91	1.051	3.12	7.48	2.44	
16	3	23	1	6.7	.7	.92	.77	54.09	1.029	4.01	1.73	1.40	
17	4	25	2	7.7	.8	2.35	1.89	59.87	1.050	2.68	7.95	2.14	
20	5	50	1	8.7	.7	1.33	1.10	64.79	1.045	3.05	6.44	1.80	
20	6	51	2	8.8	.7	2.71	2.21	52.46	1.049	3.13	6.97	1.72	
21	7	72	2	8.3	.7	2.48	2.01	51.23	1.057	2.64	10.02	2.19	
23	8	118	1	9.4	.8	1.68	1.41	58.81	1.056	2.87	9.36	1.78	Light green.
26	10	164	1	8.6	.8	1.58	1.34	60.44	1.063	2.54	11.10	2.02	Light green, starchy.
27	10	204	1	8.6	.7	1.34	1.10	63.09	1.067	2.05	12.08	3.26	Do.
28	10	238	1	8.2	.7	1.21	1.01	61.59	1.070	1.73	12.83	2.73	Do.
30	10	273	1	9.4	.7	1.57	1.38	62.45	1.075	1.86	......	......	Do.
31	11	308	1	8.9	.6	1.24	1.04	59.75	1.077	1.57	13.07	4.16	Do.
Aug. 2	11	344	1	9.0	.7	1.45	1.28	63.92	1.074	1.48	13.94	2.82	Do.
4	10	440	1	9.0	.7	1.54	1.29	64.96	1.068	1.51	13.13	2.12	Do.
9	12	560	1	9.4	.9	1.67	1.27	67.30	1.073	1.30	14.32	2.19	Do.
3	12	409	1	9.9	.7	1.51	1.29	63.25	1.073	1.65	14.10	2.75	Do.
3	12	410	1	8.8	.7	1.23	1.02	66.67	1.070	2.04	12.83	2.98	Do.
3	12	411	1	9.2	.8	1.33	1.14	64.29	1.073	2.13	13.91	2.51	Do.
3	12	412	1	8.4	.7	1.24	1.06	63.28	1.075	1.49	14.71	3.80	Do.
6	11	493	1	8.8	1.0	1.56	1.35	66.34	1.068	1.54	13.02	3.37	Do.
6	11	494	1	8.7	1.1	1.71	1.46	67.67	1.069	1.74	12.90	3.46	Do.
6	11	495	1	8.5	1.0	1.40	1.19	64.63	1.071	1.27	13.93	3.47	Do.
6	11	496	1	9.0	.9	1.39	1.21	65.57	1.070	1.72	13.25	3.39	Do.
12	14	683	1	9.6	.7	1.42	1.14	65.10	1.062	1.45	11.65	2.25	Dark green, starchy.
12	13	684	1	8.4	.8	1.40	1.12	63.90	1.068	1.25	10.71	4.55	Brownish, starchy.
12	13	685	1	8.8	.9	1.60	1.16	66.03	1.069	1.27	13.34	2.09	Dark green, starchy.
12	13	686	1	8.9	.8	1.55	1.08	65.20	1.070	1.03	13.67	2.31	Do.
16	13	813	1	9.1	.9	1.79	1.30	64.58	1.069	1.27	12.90	2.45	Do.
16	14	814	1	9.5	.9	1.70	1.30	64.92	1.065	1.79	11.46	2.67	Do.
16	14	815	1	8.3	.9	1.59	1.13	63.10	1.065	1.31	12.13	2.48	Do.
16	14	816	1	8.6	.8	1.35	1.25	46.30	1.058	1.22	10.85	2.20	Do.
19	14	985	1	9.0	.8	1.67	1.40	63.29	1.064	1.74	11.07	3.45	Do.
19	14	986	1	9.1	.8	1.80	1.53	63.40	1.068	1.62	11.75	3.86	Do.
19	14	987	1	8.7	.7	1.49	1.23	61.04	1.068	1.39	11.42	8.42	Do.
19	14	988	1	9.0	.9	1.49	1.28	59.83	1.069	1.42	12.48	3.55	Do.
21	14	1087	2	8.5	.8	2.81	2.20	*64.06	1.065	1.38	12.21	2.61	Brown, starchy.
21	14	1088	2	8.5	.8	2.81	1.60	†43.69	1.067	1.77	11.68	3.23	Reddish brown.
26	14	1260	1	9.2	.8	1.99	1.21	58.51	1.067	1.08	12.21	2.92	Dark brown, starchy.

*Juice expressed by mill. †Juice expressed in press.

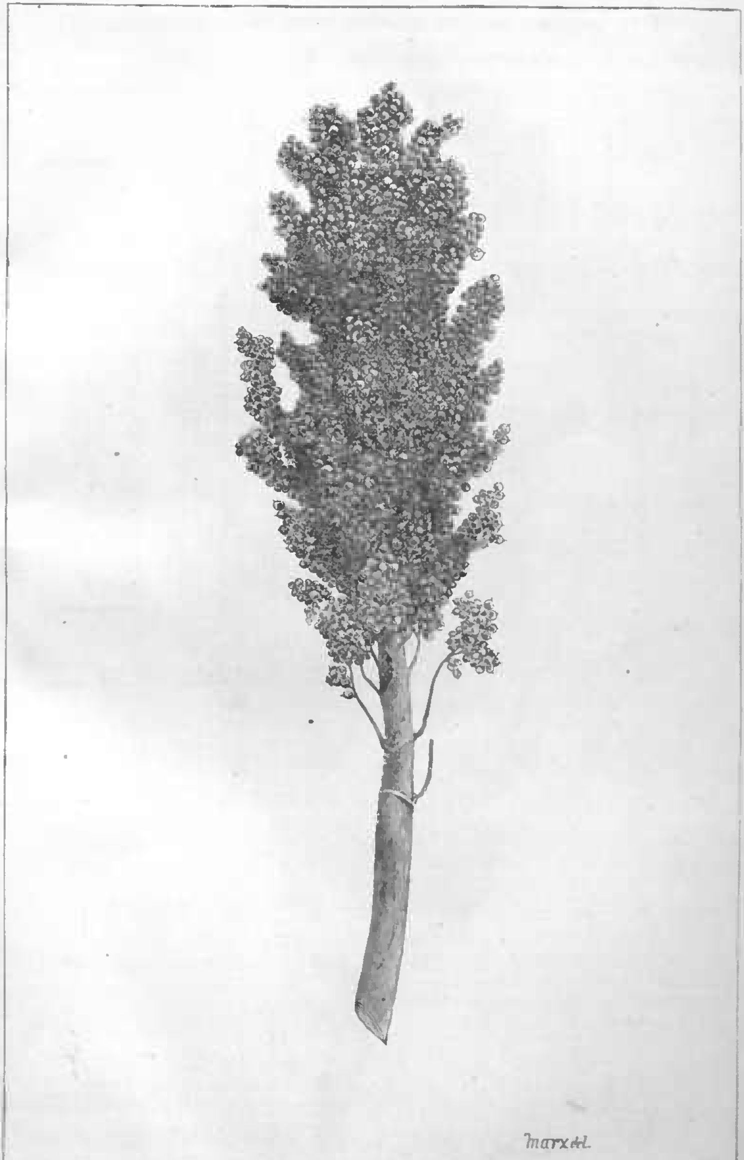
ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	In.	Lbs.	Lbs.	Pr. ct.		Pr. ct.	Pr. ct.	Pr. ct.	
Aug. 26	12	1261	1	9.0	0.8	1.94	1.26	57.53	1.076	.85	14.87	2.68	Dark green, starchy.
26	16	1262	1	8.6	1.0	1.32	.88	62.50	1.056	1.60	9.39	2.88	Dark brown, starchy.
26	14	1263	1	8.9	.9	1.42	1.01	63.13	1.067	1.23	11.92	3.25	Do.
30	14	1437	1	8.8	.9	1.68	1.11	67.76	1.060	1.53	12.80	1.09	Do.
30	12	1438	1	8.9	.9	1.91	1.33	56.70	1.077	1.00	14.65	3.90	Do.
30	12	1439	1	8.9	.9	1.51	.98	60.36	1.065	1.71	11.27	3.59	Do.
30	12	1440	1	8.8	.8	1.57	.96	60.78	1.073	.97	13.92	3.75	Do.
Sept. 3	13	1612	1	9.1	.8	2.09	1.34	59.18	1.069	1.17	13.15	2.80	Do.
3	14	1613	1	8.6	.8	1.54	1.07	63.77	1.060	1.92	10.29	2.98	Do.
3	16	1614	1	9.4	.8	1.47	.95	62.96	1.046	1.82	6.90	2.66	Do.
3	14	1615	1	8.6	.7	1.13	.71	58.02	1.065	1.12	12.19	3.26	Do.
8	16	1831	1	9.1	.7	1.16	.69	56.19	1.058	1.48	9.60	3.85	Do.
8	15	1832	1	9.0	.8	1.58	1.12	55.81	1.065	1.49	10.96	3.85	Do.
8	15	1833	1	9.0	.8	1.72	1.04	59.32	1.061	1.71	8.43	4.99	Do.
8	15	1834	1	9.0	.8	1.82	1.15	59.20	1.067	1.51	11.05	4.12	Do.
10	15	1915	1	8.4	.8	1.85	1.08	57.75	1.062	1.46	9.90	4.32	Do.
15	15	2018	1	9.0	.8	1.30	.92	56.93	1.067	1.64	11.22	4.95	Do.
15	15	2019	1	8.6	.8	.98	.68	53.74	1.065	1.33	9.44	7.45?	Do.
15	15	2020	1	8.8	.8	1.08	.66	57.39	1.063	1.63	10.05	4.55	Do.
15	15	2021	1	8.9	.8	1.06	.71	55.24	1.065	1.63	11.13	2.92	Do.
18	16	2138	1	9.0	.7	1.14	.86	55.89	1.057	1.52	9.12	3.17	Do.
18	15	2139	1	8.7	.9	1.87	1.12	57.84	1.066	1.83	11.76	3.30	Do.
18	15	2140	1	8.4	.9	1.58	.94	56.33	1.062	1.49	9.43	7.11?	Do.
18	16	2141	1	9.0	.9	1.50	1.05	53.55	1.059	1.42	9.78	4.10	Do.
24	16	2371	1	8.8	.8	1.23	.83	59.72	1.050	1.70	8.06	3.38	Do.
24	15	2372	1	8.8	.8	1.54	.86	59.23	1.063	1.73	10.73	3.91	Do.
24	15	2373	1	8.9	.8	1.66	1.18	59.10	1.067	1.30	11.82	3.98	Do.
24	16	2374	1	9.3	.8	1.57	1.00	54.84	1.052	2.27	7.84	4.86	Do.
27	15	2534	1	8.0	.8	1.19	Lost.	Lost.	1.068	1.01	13.08	2.39	Dark green, starchy.
27	16	2535	1	9.8	.7	1.27	.78	46.80	1.059	1.61	10.27	2.95	Dark brown, starchy.
27	15	2536	1	9.1	.8	1.53	1.05	59.41	1.065	1.58	11.32	3.02	Do.
27	15	2537	1	8.8	.8	1.50	.95	57.44	1.063	1.43	11.17	3.44	Do.
30	16*	2682	1	7.9	.9	1.83	1.27	63.54	1.060	1.84	8.57	3.22	Do.
Oct. 2	17	2728	1	8.9	.8	1.91	.94	62.82	1.074	.93	13.42	4.37	Yellowish.
6	17	2786	1	8.6	.8	1.80	1.13	64.04	1.076	1.14	13.86	4.20	Brownish, green, starchy.
8	17	2872	1	8.8	.9	1.54	.99	68.08	1.061	1.60	10.74	2.74	Red.
12	17	2942	1	9.0	.9	1.56	.84	61.52	1.074	.88	14.13	3.10	Light green, starchy.
14	17	2988	1	8.8	.8	1.43	.80	56.43	1.074	1.71	11.80	4.17	Dark olive.
15	18	3030	1	9.4	.9	1.43	.99	57.59	1.062	1.65	9.73	4.34	Do.
17	18	3086	1	8.4	.9	1.78	.96	62.47	1.056	2.04	9.08	3.46	Do.
19	18	3112	1	7.7	.8	1.39	.83	42.59	1.069	1.46	12.05	3.57	Do.
21	18	3145	1	9.2	.8	.96	.72	57.29	1.060	2.24	9.07	5.28	Olive.
22	18	3180	1	9.0	.8	1.32	.84	57.63	1.063	1.89	10.50	3.27	Dark olive.
26	18	3253	1	9.4	.9	1.42	1.10	53.78	1.06[illegible]	1.59	10.79	3.78	Olive.
28	18	3298	1	8.0	.7	.77	.58	39.25	1.063	2.26	9.98	3.89	Dark brown.
29	18	3329	1	9.0	.8	1.34	.88	61.19	1.066	1.76	10.08	4.81	Do.
Nov. 2	18†	3374	1	8.3	.8	......	.80	50.73	1.061	2.71	9.13	3.19	Dark olive.
6	18	3442	1	8.2	.9	1.26	.97	58.82	1.069	1.34	11.09	3.74	Do.
8	18	3457	1	8.5	.7	1.41	1.00	62.33	1.068	2.00	11.31	2.79	Do.
10	18	3486	1	8.3	.8	1.22	.76	54.05	1.065	2.43	9.87	4.41	Do.
10	18	3497	1	8.3	.9	1.12	.98	61.74	1.061	2.02	10.17	3.29	Olive.
13	18	3523	1	8.3	.9	1.03	.79	61.94	1.065	1.82	10.80	3.63	Dark olive.
15	18	3540	2	8.5	.7	1.52	1.26	59.96	1.057	3.43	7.30	2.96	Olive.

TABLE NO. 3.—EARLY GOLDEN. A. B. SWAIN, ELYSIAN, MINN.

July 12	1	3	2	7.0	0.6	......	1.35	63.90	1.023	3.68	.70	.77	
15	2	15	2	8.0	.6	......	1.50	40.82	1.028	3.83	2.08	5.68	
16	3	22	2	8.0	.6	1.67	1.46	48.04	1.030	4.09	2.34	1.22	
17	4	26	2	8.4	.7	1.76	1.45	52.40	1.043	3.05	6.43	1.86	
20	5	52	2	8.5	.7	2.17	1.74	58.27	1.048	3.10	7.03	1.64	
20	6	53	2	9.1	.8	2.92	2.39	54.95	1.047	3.04	7.63	1.44	
23	7	119	1	8.8	.7	1.61	1.30	47.02	1.057	2.81	9.34	2.28	Light green.
26	8	165	1	9.0	.7	1.54	1.32	62.00	1.067	2.52	11.77	1.89	Darker gr'n, starchy.
27	9	205	1	7.8	.7	1.33	1.11	60.79	1.062	2.04	11.09	2.92	Light green, starchy.
28	10	239	1	8.4	.7	1.52	1.12	39.41	1.066	1.85	11.81	2.52	Do.
30	10	274	1	8.1	.8	1.29	1.10	63.71	1.074	1.65	10.37	6.00?	Do.
31	11	309	1	7.8	.7	1.24	1.06	63.28	1.072	1.66	12.27	3.89	Do.

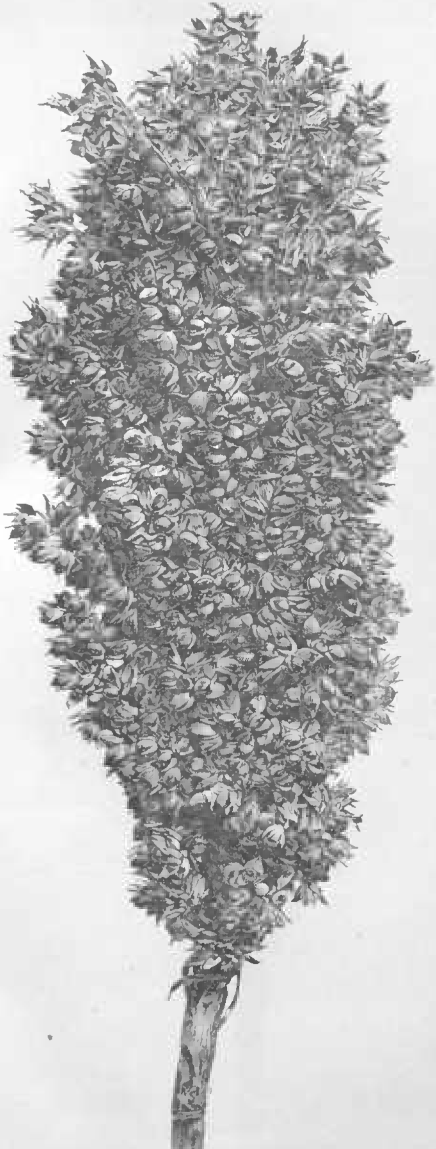
*Topped August 28. †Stripped in the field.



LIBERIAN.

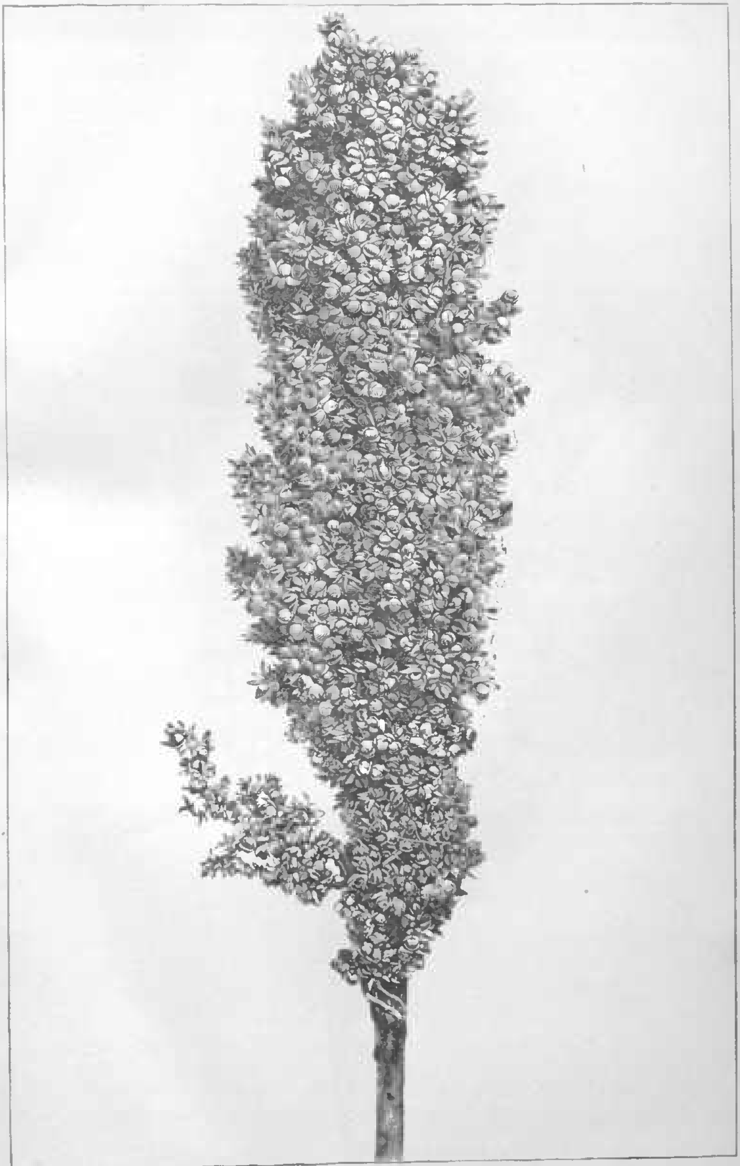
Synonyms: IMPHEE, SUMAC (CHINESE CANE).

[Grown on the Department grounds during the season of 1879.]



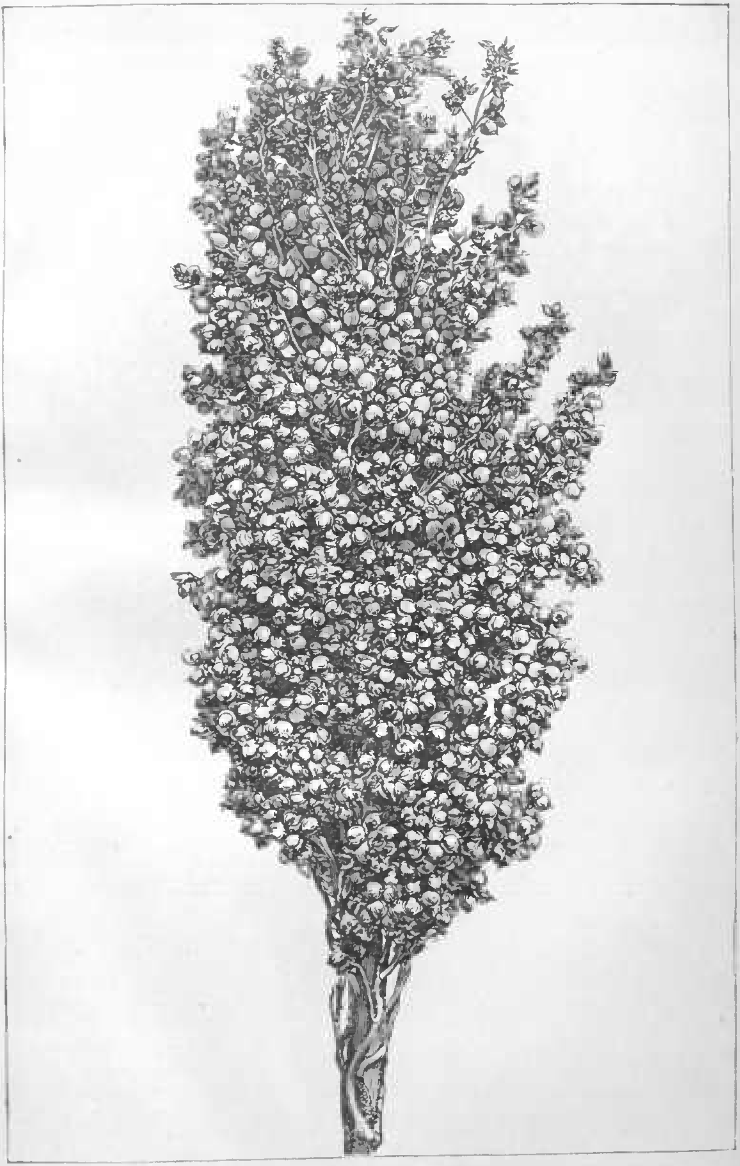
NEEAZANA.

[Grown on the Department grounds during the season of 1880.]



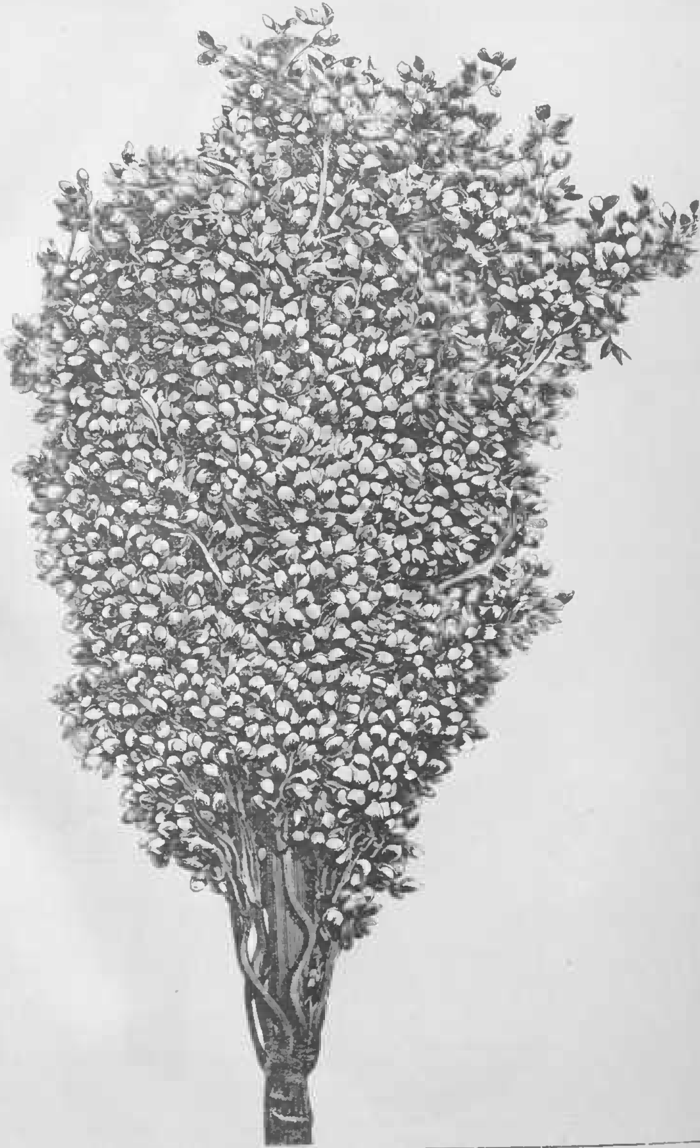
WOLF TAIL.

[Grown on the Department grounds during the season of 1880.]



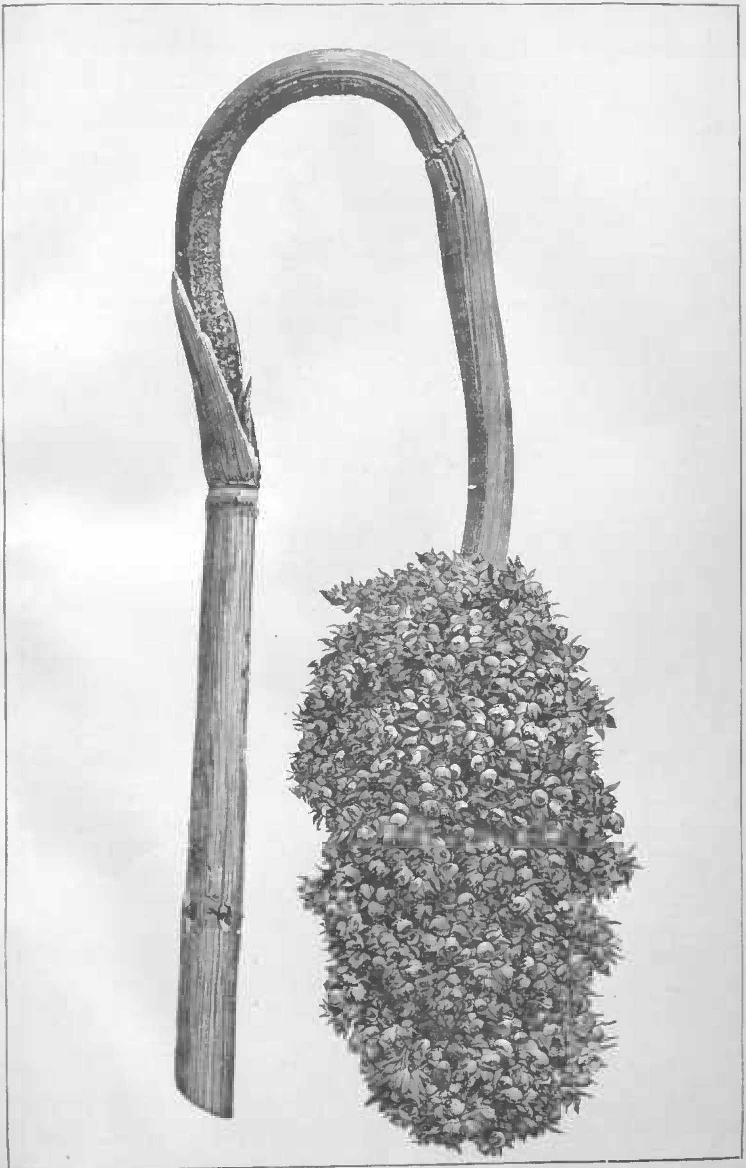
GRAY TOP.

[Grown on the Department grounds during the season of 1880.]

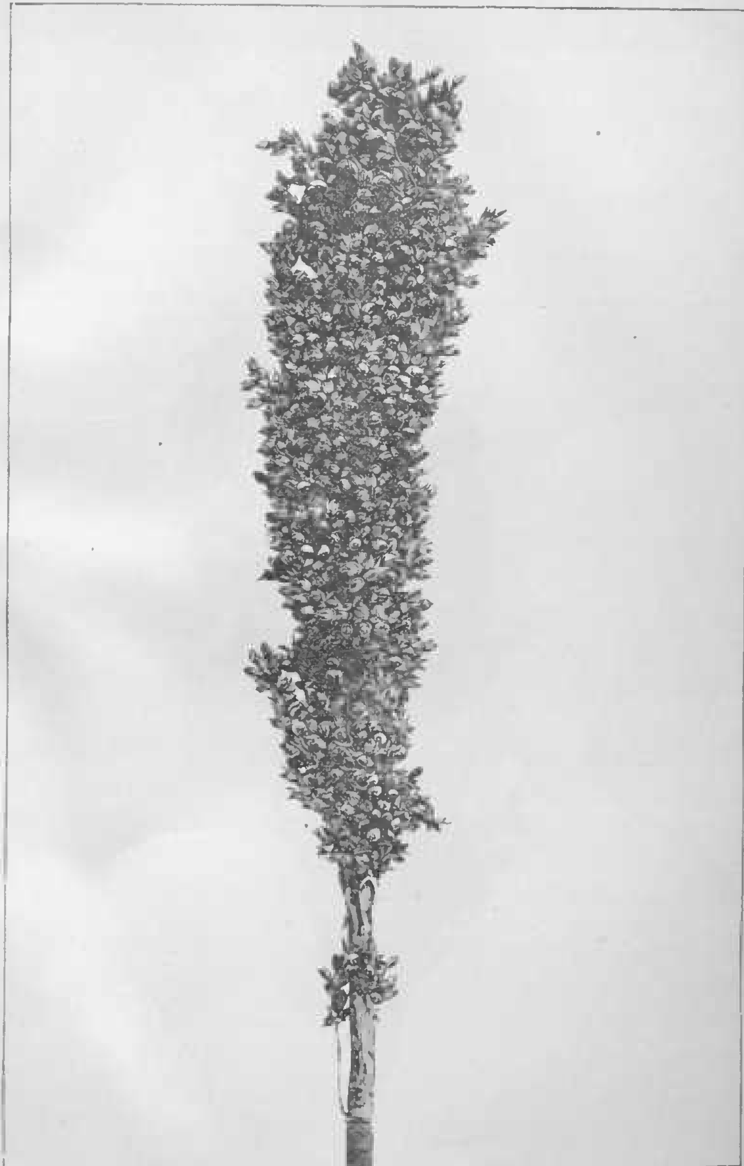


WHITE MAMMOTH.

[Grown on the Department grounds during the season of 1880.]

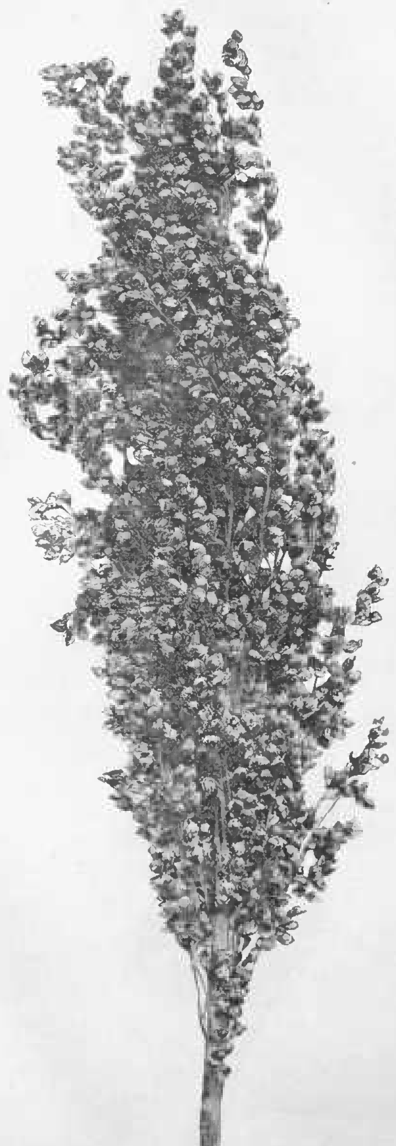


RICE, OR EGYPTIAN CORN.
[Grown on the Department grounds during the season of 1880.]

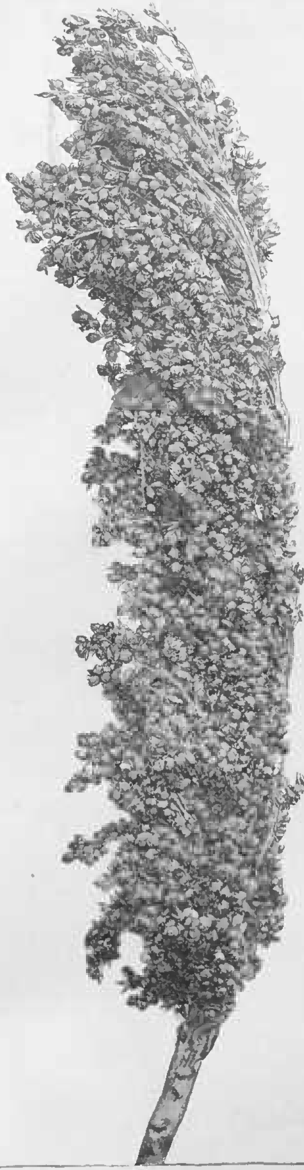


OOMSEEANA.

[Grown on the Department grounds during the season of 1880.]

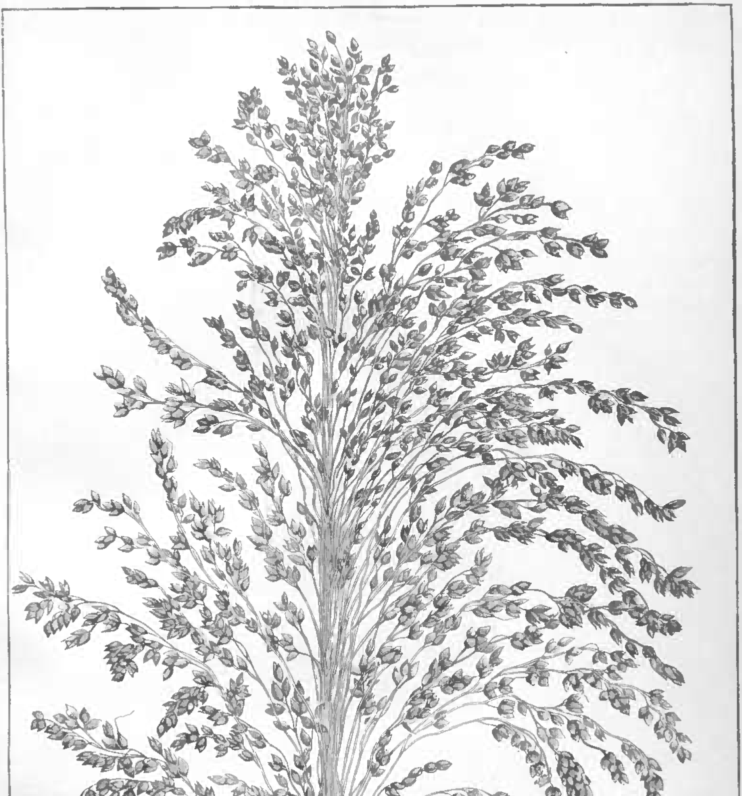


BLACK TOP.
[Grown on the Department grounds during the season of 1880.]



HYBRID, ORIGINATED BY E. LINK.

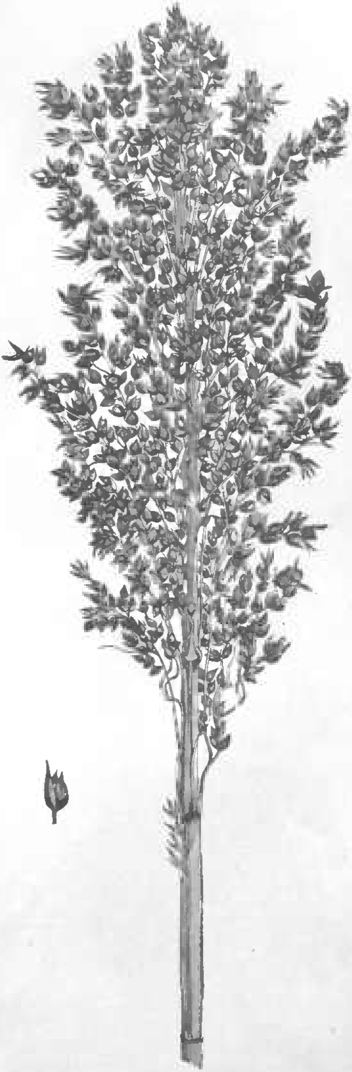
[Grown on the Department grounds during the season of 1880.]



HONDURAS.

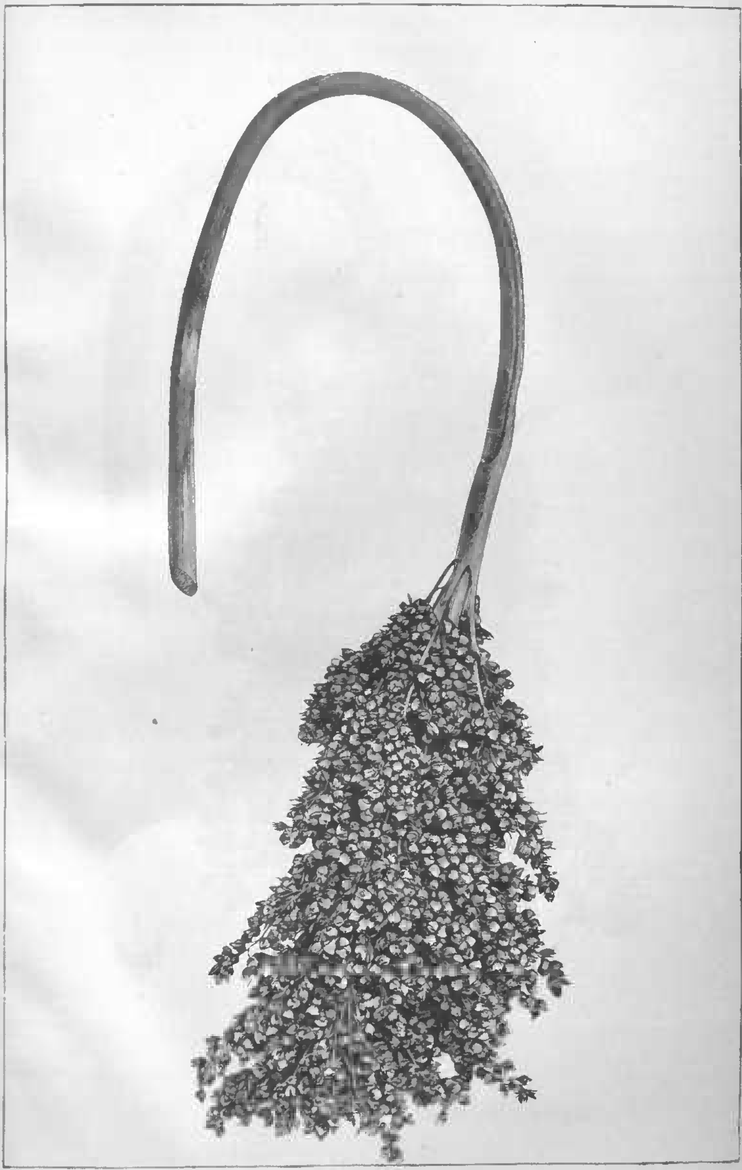
Synonyms: MASTODON, SPRANGLE-TOP, HONEY CANE.

[Grown on the Department grounds during the season of 1879.]



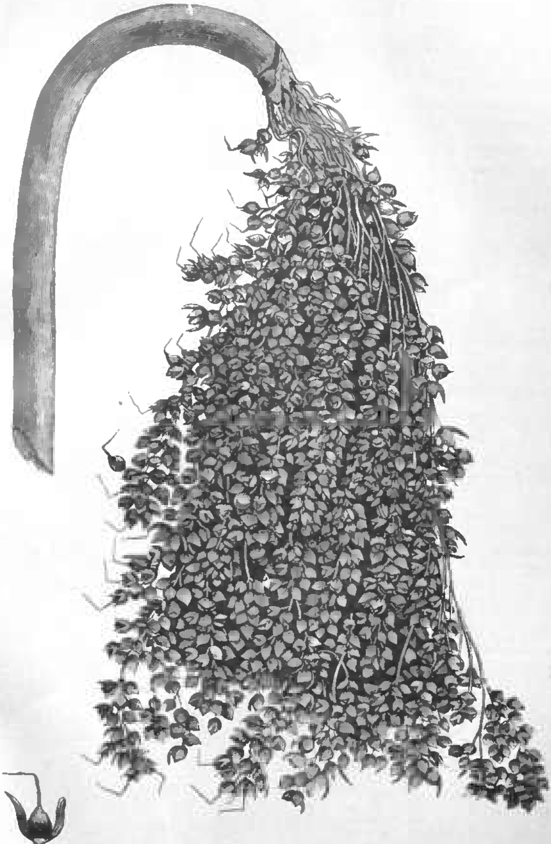
EARLY AMBER.

[Grown on the Department grounds during the season of 1879.]



GOOSE NECK.

[Grown on the Department grounds during the season of 1880.]



WHITE LIBERIAN.

[Grown on the Department grounds during the season of 1879.]

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	In.	Lbs.	Lbs.	Pr. ct.		Pr. ct.	Pr. ct.	Pr. ct.	
Aug. 2	12	345	1	9.5	0.8	1.47	1.27	65.63	1.076	1.44	13.89	3.44	Light green, starchy.
9	12	561	1	9.1	.7	1.36	1.07	76.40	1.068	1.46	13.51	2.03	Do.
3	12	413	1	9.4	.8	1.37	1.17	65.85	1.071	1.57	13.59	2.72	Do.
3	12	414	1	9.3	.7	1.64	1.41	65.23	1.073	1.66	14.36	2.29	Do.
3	12	415	1	9.4	.8	1.48	1.26	66.64	1.072	1.88	13.62	2.69	Do.
3	12	416	1	8.8	.9	1.83	1.56	65.91	1.072	1.48	13.32	3.20	Do.
6	12	497	1	9.5	.8	1.21	1.03	62.98	1.070	1.49	13.55	1.69	Do.
6	12	498	1	9.0	1.0	1.25	1.10	65.06	1.071	1.48	13.56	3.59	Darker gr'n, starchy.
6	12	499	1	9.5	1.0	1.39	1.21	66.24	1.069	1.38	12.96	3.57	Do.
6	12	500	1	8.6	1.0	1.54	1.32	68.00	1.071	1.36	13.64	3.72	Do.
12	13	687	1	9.5	.8	1.50	1.10	66.43	1.065	1.21	12.66	2.18	Dark green, starchy.
12	13	688	1	9.5	.9	1.77	1.37	63.57	1.071	1.16	13.69	2.56	Do.
12	13	689	1	8.5	.9	1.79	1.37	66.34	1.069	3.22	11.83	2.26	Do.
12	13	690	1	9.1	.8	1.67	1.35	67.72	1.067	1.20	12.60	2.69	Do.
16	13	817	1	9.5	.9	1.71	1.02	79.84	1.064	1.30	11.72	2.63	Do.
16	13	818	1	8.6	.9	1.45	1.00	64.65	1.066	1.15	12.27	2.62	Do.
16	13	819	1	8.8	.8	1.37	1.13	57.41	1.063	1.21	11.38	2.98	Do.
16	12	820	1	8.0	.7	1.50	1.34	52.68	1.073	1.22	13.77	2.62	Do.
20	13	989	1	9.1	.8	1.93	1.60	58.86	1.067	1.42	12.09	3.13	Brownish, starchy.
20	13	990	1	9.2	.7	1.19	1.01	56.74	1.063	1.14	10.74	3.78	Do.
20	13	991	1	9.3	.9	1.44	1.23	57.27	1.062	1.15	11.04	3.16	Do.
20	15	992	1	8.5	.7	1.30	1.10	61.55	1.055	1.65	9.06	3.33	Do.
23	14	1131	1	9.5	.8	1.38	.93	58.89	1.062	1.25	11.35	2.94	Dark brown, starchy.
23	13	1132	1	9.4	.7	1.40	.96	55.02	1.072	1.08	13.24	3.54	Do.
23	14	1133	1	8.1	.8	1.42	1.02	68.14	1.060	1.72	10.46	3.01	Do.
23	14	1134	1	8.2	.8	1.18	.85	52.83	1.059	1.66	9.70	3.09	Do.
26	14	1264	1	8.6	.9	1.63	1.32	63.54	1.056	1.54	9.38	3.05	Do.
26	14	1265	1	9.1	.8	1.84	1.18	63.50	1.063	1.96	10.16	3.31	Do.
26	12	1266	1	8.4	.9	1.58	1.02	61.29	1.076	1.05	14.01	3.30	Dark green, starchy.
26	14	1267	1	8.1	.8	1.74	1.09	65.36	1.059	1.74	10.26	2.02	Dark brown, starchy.
31	15	1441	1	8.8	.8	1.56	1.01	57.54	1.047	2.21	6.79	2.60	Do.
31	15	1442	1	8.8	.8	1.84	1.19	63.30	1.056	1.60	9.28	2.85	Do.
31	14	1488	1	9.5	.7	1.56	1.17	62.08	1.066	1.72	11.40	2.92	Do.
31	14	1489	1	9.0	.7	1.45	1.03	55.98	1.063	1.23	10.51	3.69	Do.
Sept. 3	14	1616	1	9.6	.8	1.72	1.22	60.90	1.063	1.51	11.95	2.58	Do.
3	14	1617	1	8.1	.9	1.58	1.12	71.57	1.066	2.04	11.94	2.63	Dark green, starchy.
3	14	1618	1	8.5	.9	1.59	1.05	58.49	1.060	1.20	11.00	3.18	Dark brown, starchy.
3	15	1619	1	8.5	.9	1.53	.99	59.55	1.058	1.39	10.24	3.07	Do.
8	15	1835	1	8.6	.7	1.41	.97	62.77	1.056	1.59	8.95	3.76	Do.
8	15	1836	1	9.5	.8	1.38	.98	49.21	1.058	1.55	8.61	4.87?	Do.
8	15	1837	1	8.5	.7	1.12	.73	57.19	1.051	1.65	9.50	4.47?	Do.
8	15	1838	1	7.0	.7	1.41	.94	61.07	1.056	1.65	8.65	—.59?	Do.
16	13	2023	1	8.5	.7	1.50	.95	51.62	1.072	1.50	13.09	6.12?	Do.
16	13	2024	1	8.2	.7	1.51	1.25	62.97	1.070	1.67	13.00	2.29	Dark green, starchy.
16	15	2025	2	8.9	.7	2.15	1.60	62.08	1.059	1.98	9.75	2.58	Dark brown, starchy.
16	15	2026	1	8.8	.7	1.21	.92	58.99	1.054	1.90	7.91	3.24	Do.
18	16	2142	1	9.3	.8	1.64	1.18	54.74	1.061	1.93	9.78	5.63	Do.
18	13	2143	1	9.8	.8	1.91	1.30	56.85	1.071	1.33	12.71	3.84	Do.
18	16	2144	1	9.0	.9	1.53	1.09	54.94	1.064	1.80	10.57	4.31	Do.
18	16	2145	1	9.0	.9	1.34	.98	56.19	1.054	1.57	8.38	5.09	Do.
24	16	2375	1	8.5	.8	1.22	.74	57.98	1.059	1.33	10.24	4.81	Do.
24	14	2376	1	9.0	.8	1.17	.73	56.76	1.061	1.51	10.24	4.27	Do.
24	14	2377	1	8.8	.8	1.35	.93	55.80	1.063	1.45	10.88	4.65	Do.
24	14	2378	1	8.0	.9	1.76	1.10	59.76	1.068	1.38	11.79	4.06	Do.
27	16	2538	1	8.7	.8	.99	.69	46.03	1.051	1.93	8.29	2.67	Do.
27	14	2539	1	8.3	.7	.93	.50	58.66	1.069	1.60	12.25	3.13	Do.
27	14	2540	1	9.3	.9	1.43	1.01	55.48	1.067	1.29	12.26	3.23	Do.
27	15	2541	1	8.7	.8	1.44	1.14	45.00	1.058	1.63	9.56	3.08	Do.
30	13*	2683	1	6.9	.8	1.52	1.16	60.03	1.073	1.27	12.85	3.40	Dark green, starchy.
Oct. 2	16	2729	1	8.6	.8	1.28	.88	57.00	1.060	2.19	8.67	4.47	Dark red brown.
6	14	2787	1	9.0	1.0	1.39	.90	61.51	1.068	1.37	11.62	4.06	Dark olive, starchy.
8	14	2873	1	8.8	.8	1.32	.82	55.64	1.065	1.58	11.09	3.34	Red.
12	16	2943	1	7.6	.8	2.00	.95	65.43	1.055	1.90	9.34	2.79	Dark olive, starchy.
14	17	2989	1	8.6	.9	1.52	.85	56.10	1.081	1.20	13.89	4.30	Olive.
15	16	3031	1	8.1	.8	1.03	.70	60.69	1.052	2.32	7.46	3.77	Dark olive.
17	16	3087	1	8.0	.7	.79	.55	60.40	1.061	1.95	10.13	3.09	Dirty green.
19	17	3113	1	7.6	.7	.90	.59	51.49	1.071	1.69	12.25	3.67	Dark olive.
21	16	3146	1	8.1	.7	1.00	.56	52.34	1.060	2.90	8.78	3.37	Do.
25	16	3206	1	8.4	.9	1.23	.79	55.83	1.053	2.73	7.56	3.05	Deep brown.
26	18	3254	1	9.3	.8	1.12	.96	55.63	1.060	2.13	10.74	1.80	Olive.
28	18	3299	1	7.6	.7	.68	.48	65.45	1.063	1.82	9.49	3.55	Dark brown.
29	18	3330	1	8.5	.8	.94	.67	58.17	1.063	2.56	9.41	4.07	Do.

* Topped August 28.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Nov. 2	17	3375	1	8.5	1.0	......	1.41	67.60	1.075	1.83	13.61	2.41	Light green.
6	17	3448	1	8.3	1.0	1.42	1.11	62.57	1.073	1.26	13.61	2.87	Dark olive.
8	18	3458	1	9.0	.7	.84	.75	58.36	1.058	2.63	8.62	3.53	Do.
9	18	6469	1	9.0	.8	1.00	.85	65.55	1.066	1.91	11.15	3.20	Dirty brown.
10	18	3498	1	8.0	.8	.99	.80	60.82	1.067	2.14	12.48	2.18	Dark olive.
13	17	3524	1	8.0	1.0	2.03	1.63	65.86	1.074	1.07	14.13	Lost.	Dark green.
15	18	3541	1	8.0	.7	1.36	.80	57.58	1.060	2.89	10.97	1.42	Olive.

TABLE NO. 4.—GOLDEN SIRUP. WILLIAM H. LYTLE, YELLOW SPRINGS, OHIO.

July 12	1	4	2	7.2	0.8	.....	1.65	65.82	1.021	3.59	.48	.87	
16	2	17	2	7.3	.7	1.63	1.32	48.07	1.028	3.81	2.22	3.09	
17	3	38	1	8.4	.6	.96	.79	53.55	1.036	4.05	3.61	1.87	
19	4	39	2	8.3	.7	1.96	1.66	44.12	1.042	3.97	5.28	1.41	
20	5	70	2	7.8	.6	1.97	1.59	62.71	1.043	3.81	5.38	1.83	
21	6	83	1	9.1	.7	1.20	.98	50.01	1.046	2.34	7.37	2.24	
22	7	102	1	8.4	.7	1.40	1.08	....	1.054	2.73	....	.....	
24	7	147	1	7.5	.7	1.57	1.33	59.39	1.053	2.76	8.83	1.85	Light green, very starchy.
23	8*	129	1	9.0	.8	1.77	1.42	56.41	1.053	2.99	8.33	2.17	Light green, starchy.
26	9	176	1	8.3	.7	1.18	.96	64.14	1.055	3.44	8.61	1.88	Do.
27	10	226	1	8.7	.7	1.11	1.06	62.67	1.065	2.14	11.23	3.11	Do.
29	10	254	1	8.1	.7	1.56	1.29	65.04	1.069	2.02	10.80	4.30	Dark green, starchy.
30	10	288	1	9.2	.7	1.39	1.18	63.35	1.071	2.02	12.23	3.40	Lighter green, starchy.
31	10	327	1	9.0	.7	1.44	1.34	65.49	1.072	1.87	13.46	2.53	Do.
Aug 2	10	360	1	8.7	.8	1.39	1.19	70.19	1.068	2.37	12.40	2.83	Light green, starchy.
4	10	431	1	9.3	.8	1.64	1.35	62.89	1.070	1.37	13.84	2.13	Do.
6	10	514	1	9.0	.4	1.18	1.02	64.30	1.073	......	....	.....	Dark green, starchy.
7	10	542	1	8.9	.8	1.48	1.25	66.19	1.071	1.70	13.24	2.47	Do.
9	11	576	1	8.9	.8	1.23	.98	64.85	1.070	1.73	13.46	2.53	Watery, some starch.
3	11	401	1	10.0	.8	1.69	1.44	66.26	1.075	2.03	13.86	2.90	Light green, starchy.
3	11	403	1	8.9	.7	1.17	.99	68.22	1.065	2.17	11.62	2.45	Do.
3	11	403	1	8.7	.8	1.20	1.08	66.53	1.075	2.05	14.02	3.00	Do.
3	11	404	1	9.4	.7	1.50	1.31	67.11	1.073	1.74	13.29	3.33	Do.
July 29	10	269	2	9.3	.7	3.08	2.57	68.55	1.062	2.53	10.89	Lost	Do.
29	10	270	2	9.2	.7	3.01	2.56	68.64	1.067	2.51	11.53	Lost	Do.
29	10	271	2	8.4	.8	3.00	2.45	67.98	1.068	2.06	12.23	Lost	Do.
29	10	272	2	8.5	.7	2.81	2.34	68.73	1.064	2.35	11.18	Lost	Do.
Aug. 13	11	748	1	8.8	.8	1.51	1.19	63.89	1.066	1.56	12.50	2.45	Dark green, starchy.
13	11	749	1	8.6	.9	1.65	1.30	64.60	1.074	1.07	14.81	2.59	Do.
13	11	750	1	8.5	.9	1.78	1.37	63.12	1.075	.99	14.72	2.42	Do.
13	11	751	1	9.0	.8	1.28	.98	65.32	1.067	1.42	12.57	2.69	Do.
17	10	879	1	9.1	.8	1.50	1.22	62.70	1.070	1.37	11.38	4.12	Do.
17	12	880	1	8.4	.9	1.58	1.31	60.99	1.079	.93	14.76	3.31	Do.
17	12	881	1	8.2	.8	1.62	1.28	62.44	1.076	1.01	14.06	3.29	Do.
17	12	882	1	9.2	.9	1.40	1.12	64.93	1.075	1.29	13.26	3.59	Do.
21	12	1060	1	8.7	.9	1.80	1.55	61.56	1.072	1.29	13.48	3.33	Do.
21	10	1061	1	9.0	.9	1.21	1.00	61.37	1.052	1.44	11.12	.84	Do.
21	11	1062	1	9.0	.9	1.27	.96	61.88	1.061	1.40	10.46	3.55	Do.
21	11	1063	1	8.9	.8	1.38	1.13	58.56	1.066	1.46	11.34	4.23	Do.
25	10	1103	1	9.0	.8	1.65	.88	55.89	1.057	1.10	10.41	2.73	Dark brown, starchy.
25	13	1104	1	9.6	.9	1.76	1.36	58.00	1.081	.84	15.46	3.27	Dark green, starchy.
25	13	1105	1	8.1	.8	1.48	1.09	62.22	1.075	.85	15.13	2.62	Do.
25	14	1106	1	9.1	.8	1.47	1.10	60.50	1.065	1.48	12.08	2.78	Dark brown, starchy.
27	14	1323	1	9.5	.8	1.53	1.14	59.61	1.066	1.42	11.64	3.45	Do.
27	14	1324	1	9.5	.9	1.54	1.11	61.11	1.060	1.56	11.38	3.62	Do.
27	14	1325	1	9.1	.8	1.54	1.10	62.55	1.065	1.36	10.97	3.77	Do.
27	14	1326	1	9.5	.8	1.55	1.18	64.00	1.068	1.30	12.44	3.33	Do.
Sept. 2	12	1545	1	9.0	.7	1.57	1.16	62.99	1.071	1.09	13.60	2.54	Dark green, some starch.
2	12	1546	1	9.6	.7	1.71	1.27	61.00	1.071	1.04	13.89	2.62	Do.
2	14	1547	1	8.6	.7	1.25	.91	62.89	1.053	1.41	9.71	2.08	Dark brown, starchy.
2	14	1548	1	8.6	.7	1.60	1.10	58.40	1.068	1.33	12.12	3.12	Do.
6	15	1697	1	9.4	.7	1.30	.90	70.76	1.054	1.59	9.87	2.39	Do.
6	14	1698	1	9.1	.7	1.56	1.08	56.32	1.065	1.50	11.57	3.03	Do.
6	15	1699	1	8.5	.8	1.35	.92	56.48	1.054	1.58	9.54	2.54	Do.

* Suckered.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Sept. 6	15	1700	1	8.5	0.7	1.06	.75	55.24	1.054	1.72	8.96	2.51	Dark brown, starchy.
9	14	1892	1	9.0	.8	1.58	1.13	60.97	1.054	1.40	11.06	2.43	Do.
9	15	1893	1	8.7	.9	1.36	.95	62.73	1.057	1.38	9.58	3.18	Do.
9	15	1894	1	9.0	.8	1.34	.95	60.37	1.065	1.38	10.88	3.65	Do.
9	15	1895	1	9.4	.8	1.47	1.23	58.39	1.063	1.39	10.64	......	Do.
17	12	2086	1	9.3	.9	1.56	1.19	58.33	1.070	1.58	13.10	3.82	Do.
17	15	2087	1	8.4	.9	1.45	1.01	59.82	1.068	1.45	11.00	4.92	Do.
17	15	2088	1	8.5	.9	1.21	.90	59.26	1.063	1.73	11.66	2.97	Do.
17	15	2089	1	8.0	.9	1.34	1.07	56.61	1.058	1.45	10.07	3.27	Do.
21	15	2201	1	8.4	.7	1.05	.65	46.44	1.066	1.36	11.78	3.09	Do.
21	15	2202	1	7.5	.7	.92	.66	61.00	1.063	2.06	11.16	2.16	Do.
21	15	2203	1	9.3	.8	1.53	.87	75.88	1.068	1.21	12.64	2.58	Do.
21	15	2204	1	8.3	.8	1.36	.94	59.24	1.061	1.68	10.89	2.46	Do.
24	13	2431	1	8.8	.8	1.08	.78	57.62	1.073	.92	9.86	4.88	Do.
24	16	2432	1	8.6	.8	1.03	.76	57.22	1.068	1.18	12.89	3.30	Do.
24	16	2433	1	8.8	.9	1.45	1.04	61.65	1.065	1.56	11.74	2.99	Do.
24	16	2434	1	8.8	.8	1.15	.71	52.50	1.064	1.67	10.87	3.16	Do.
28	15	2614	1	9.1	.8	1.13	.85	55.44	1.055	1.90	9.50	2.06	Do.
28	16	2615	1	8.5	.7	.85	.62	57.77	1.071	1.40	12.84	2.89	Do.
28	16	2616	1	8.1	.9	1.56	1.04	61.65	1.063	1.82	11.27	2.20	Do.
28	15	2617	1	11.2	1.0	1.26	.69	43.49	1.056	.49	9.91	1.58	Dark green, some starch.
Oct. 1	16*	2697	1	7.5	.8	1.20	.92	58.65	1.062	1.81	9.87	3.90	Dark brown.
4	16	2747	1	9.0	.8	1.15	.86	58.93	1.064	1.37	11.98	3.29	Do.
7	16	2815	1	8.3	.8	1.50	......	......	1.070	1.19	13.29	4.43	Olive.
11	16	2907	1	9.0	.8	1.32	1.05	62.26	1.075	......	......	......	Dark green.
13	16	2977	1	8.2	.8	1.19	.97	61.52	1.068	1.69	11.27	3.57	Very dark olive.
15	17	3009	1	8.3	.8	1.28	1.15	60.87	1.074	.94	Lost.	Lost	Olive.
16	17	3046	1	8.1	.9	1.21	Lost	Lost	1.068	1.58	12.62	3.50	Do.
19	17	3103	1	8.2	.8	2.42	.92	59.29	1.068	.81	12.96	8.37	Dark olive.
20	17	3130	1	8.3	.6	1.31	.98	60.40	1.068	1.76	11.84	3.53	
22	17	3165	1	9.1	.9	1.12	.76	54.78	1.071	1.80	11.60	4.12	Olive.
25	17	3220	1	8.7	.8	.99	.81	55.14	1.074	2.59	12.53	4.38	Do.
27	17	3276	1	8.9	.9	1.33	.97	59.28	1.075	1.80	13.54	4.24	Do.
29	18	3315	1	8.3	.8	1.13	.88	64.25	1.067	2.08	11.38	2.42	Dark brown.
30	18	3345	1	8.5	.8	1.51	.77	56.44	1.072	1.46	12.43	4.44	Do.
Nov. 3	18	3394	1	8.2	.8	1.03	.81	62.94	1.062	1.78	10.54	3.08	Dark olive.
5	18	3430	1	9.3	.6	1.36	1.06	55.42	1.046	3.64	4.89	2.85	Light olive.
10	18	3487	1	9.0	.9	1.29	1.04	58.95	1.062	1.74	10.31	3.46	Dark olive.
12	18	3508	1	8.3	.7	.61	.51	54.94	1.049	1.88	5.91	6.53	Olive.

TABLE NO. 5.—WHITE LIBERIAN. D. SMITH, ARLINGTON, VA.

July 12	1	5	2	7.0	0.9	......	2.38	46.57	1.023	3.28	1.19	.70	
16	2	20	2	7.8	.8	2.87	2.38	47.07	1.028	3.81	2.45	.87	
17	3	31	1	8.2	.7	1.43	1.19	51.53	1.028	3.68	2.35	2.05	
17	4	35	1	7.7	.8	1.71	1.41	42.28	1.031	3.21	3.70	1.72	
21	5	75	1	8.0	.9	1.66	1.39	43.87	1.039	3.58	5.11	1.62	
21	6	76	1	9.0	.8	1.98	1.65	57.00	1.047	3.16	7.20	2.03	
23	7	121	1	8.7	.8	1.79	1.46	63.20	1.045	3.30	6.30	1.98	Light green.
26	8	167	1	7.4	.8	1.63	1.35	64.84	1.051	2.99	8.46	1.63	Darker green.
27	9	207	1	8.8	.8	1.79	1.65	41.60	1.054	2.94	8.93	2.03	Light green, starchy.
28	10	241	1	8.4	.8	1.73	1.46	62.72	1.061	2.34	10.76	2.07	Dark green, starchy.
30	10	276	1	8.7	.8	1.72	1.47	70.37	1.064	2.53	9.08	4.32	Light green, starchy.
31	10	311	1	8.8	.8	1.66	1.38	67.15	1.066	2.40	11.31	2.71	Do.
Aug. 2	10	347	1	9.2	.9	1.88	1.63	52.92	1.0[illegible]6	2.24	11.69	2.77	Do.
9	12	563	1	8.0	.9	1.81	1.43	71.23	1.070	1.67	13.51	2.30	Do.
3	11	417	1	8.2	.7	1.31	1.07	67.93	1.065	2.35	11.26	2.92	Do.
3	11	418	1	8.4	.8	1.73	1.50	67.23	1.069	1.70	11.63	3.93	Do.
3	11	419	1	8.5	.8	1.71	1.45	69.55	1.065	2.14	11.71	2.68	Do.
3	11	420	1	8.5	.8	1.73	1.53	66.00	1.069	1.89	11.81	3.79	Do.
6	12	501	1	9.5	1.8	2.20	1.88	65.08	1.070	1.69	13.08	3.64	Dark green, starchy.
6	12	502	1	8.0	1.1	1.43	1.18	67.29	1.069	1.68	12.84	3.63	Do.
6	12	503	1	8.2	1.2	1.54	1.35	66.34	1.070	1.48	12.75	4.07	Do.
6	12	504	1	8.5	1.2	1.80	1.56	64.64	1.071	1.96	12.69	3.70	Do.
12	11	695	1	8.4	.9	1.97	1.46	68.02	1.067	1.54	13.07	2.02	Do.
12	11	696	1	8.2	.9	1.77	1.50	67.06	1.068	1.52	13.00	2.33	Do.

* Topped August 28.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.		Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
					Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Aug.	12	13	697	1	9.0	.9	1.72	1.43	67.79	1.070	1.54	13.08	2.58	Dark green, starchy.
	12	13	698	1	9.2	.9	1.95	1.23	60.89	1.073	1.13	13.31	2.99	Do.
	16	13	825	1	7.3	.8	1.43	1.18	66.10	1.072	1.35	13.25	2.61	Do.
	16	12	826	1	8.8	.8	2.12	1.38	69.04	1.066	1.24	12.80	2.10	Do.
	16	12	827	1	8.9	.8	1.41	1.06	66.04	1.068	1.70	12.00	2.69	Do.
	16	14	828	1	8.3	.8	2.01	1.39	64.85	1.075	1.05	14.41	2.49	Do.
	20	13	997	1	8.0	.7	1.50	1.26	60.91	1.071	1.26	12.50	3.79	Do.
	20	13	998	1	8.3	.9	1.45	1.19	65.13	1.071	1.11	13.44	3.05	Do.
	20	14	999	1	8.9	.9	1.88	1.57	64.83	1.073	1.10	14.20	3.06	Do.
	20	14	1000	1	8.2	.8	1.67	1.36	62.89	1.074	.90	14.49	3.00	Do.
	24	15	1139	1	9.2	.9	1.94	1.52	60.46	1.071	1.46	13.58	2.65	Do.
	24	15	1140	1	9.2	.9	1.81	1.30	62.67	1.072	.89	14.11	2.63	Do.
	24	15	1141	1	8.7	.9	1.94	1.50	66.72	1.070	.95	13.44	2.99	Do.
	24	15	1142	1	8.8	.8	1.87	1.47	64.40	1.070	1.52	12.98	3.21	Do.
Sept.	3	10	1624	1	8.8	1.0	1.96	1.32	66.44	1.058	1.90	11.17	1.77	Dark brown, starchy.
	3	11	1625	1	8.4	1.0	1.84	1.33	60.59	1.066	1.36	12.65	2.69	Dark green, starchy.
	3	15	1626	1	8.5	1.0	1.83	1.29	66.32	1.070	.93	14.04	2.60	Do.
	3	16	1627	1	8.6	1.0	1.87	1.36	65.26	1.073	.92	14.35	2.76	Do.
	16	13	2031	1	8.8	.8	2.07	1.57	62.79	1.069	1.23	13.10	2.51	Do.
	16	11	2032	1	6.8	.8	1.94	1.36	67.58	1.062	1.27	11.74	2.39	Do.
	16	16	2033	1	8.1	.7	1.37	1.06	62.89	1.071	.97	13.54	3.00	Do.
	16	16	2034	1	7.6	.8	1.13	1.04	61.65	1.074	1.09	14.05	3.39	Do.
Oct.	4	15	2734	1	8.6	1.0	1.44	1.29	64.39	1.072	1.03	14.00	2.97	Do.
	6	16	2789	1	9.3	.8	1.20	1.13	45.50	1.067	1.11	12.14	3.43	Dark olive, starchy.
	8	16	2875	1	8.4	.8	1.50	1.08	54.89	1.060	1.86	10.46	2.54	Red.
	13	16	2064	1	8.0	.9	1.17	.80	59.94	1.071	1.32	12.72	3.29	Dark olive.
	27	....	3263	1	8.7	.8	1.18	1.00	61.32	1.019	.67	2.20	3.12	Cinnamon.
	28	17	3301	1	7.6	1.0	1.82	1.60	59.75	1.086	.98	15.20	5.23	Dirty green.
	30	17	3332	1	8.5	1.0	1.97	1.23	60.71	1.080	.84	15.69	3.84	Green.
Nov.	2	17	3377	1	9.5	1.1	......	2.29	62.75	1.083	1.64	12.04	6.50	Dark green.
	6	18	3445	1	8.7	1.0	.91	.82	62.93	1.072	1.61	12.74	2.93	Dark olive.
	8	18	3460	1	7.8	1.0	1.27	1.11	63.56	1.060	1.72	10.46	2.39	Do.
	9	18	3471	1	8.5	.9	1.32	1.03	61.75	1.061	3.18	8.62	3.10	Do.
	10	18	3500	1	8.8	.8	.93	.78	62.82	1.050	1.50	7.62	4.26	Do.
	13	17	3526	1	8.8	1.0	2.45	2.04	65.73	1.081	1.19	14.27	Lost.	Dark green.
	15	18	3543	1	9.0	.8	1.45	1.14	66.22	1.070	1.32	12.62	3.05	Dark olive green.

TABLE No. 6.—EARLY AMBER. S. E. EVANS, MONROE, KANS.

July	15	1	10	2	6.3	0.6	......	1.42	51.38	1.021	4.22	.60	.49	
	16	2	19	2	8.3	.7	1.46	1.17	52.67	1.028	4.38	1.39	1.51	
	20	3	61	2	7.5	.6	2.01	1.58	62.13	1.043	4.60	3.71	2.48	
	21	4	85	2	7.8	.6	1.68	1.10	56.33	1.035	4.34	3.19	.88	
	22	4	88	2	8.3	.7	1.93	1.54	63.36	1.037	4.52	3.61	1.88	
	22	5	89	2	8.5	.6	2.32	1.85	57.05	1.045	4.13	5.50	2.04	
	23	6	90	2	9.0	.7	2.55	2.09	52.77	1.049	3.76	6.67	2.20	
	24	7	134	1	8.2	.7	1.24	.97	67.72	1.041	3.79	5.91	1.51	Light green, starchy.
	26	8	182	1	7.8	.7	1.44	1.13	50.80	1.051	2.85	8.82	1.41	Do.
	26	9	188	1	7.5	.7	1.16	.92	62.64	1.046	3.94	6.54	1.47	Do.
	27	9	229	1	8.2	.7	1.21	.96	60.14	1.052	2.22	8.64	2.78	Do.
	29	9	258	1	9.0	.7	1.33	1.12	68.38	1.055	3.22	8.62	2.14	Do.
	30	9	296	2	8.4	.6	2.07	1.76	69.17	1,060	3.22	9.49	2.38	Do.
	31	10	340	1	8.9	.7	1.26	1.09	68.89	1.060	3.18	9.60	2.69	Do.
Aug.	2	10	365	1	9.6	.9	1.55	1.34	67.05	1.065	3.20	9.89	3.58	Do.
	4	10	436	1	8.7	.7	1.68	1.41	69.11	1.066	2.29	11.97	2.99	Do.
	6	10	521	1	8.7	.4	1.42	1.21	62.68	1.069	2.48	11.79	2.30	Dark green, starchy.
	7	12	551	1	9.0	.7	1.45	1.21	63.14	1.072	1.94	13.18	2.79	Dark green, watery.
	9	11	585	1	8.4	.9	1.53	1.28	62.61	1.071	1.83	12.84	3.07	Dark green, starchy.
	19	10	939	1	9.2	.8	1.67	1.41	57.97	1.060	1.59	10.72	2.83	Do.
	19	15	940	1	8.8	.9	1.71	1.46	56.24	1.079	1.57	14.49	3.31	Do.
	20	14	1037	1	9.2	.8	1.62	1.34	60.74	1.072	1.56	(*)	......	Do.
	20	12	1038	1	9.1	.7	1.52	1.22	56.48	1.068	1.54	(*)	......	Do.
	23	12	1123	1	8.5	.8	1.57	1.10	60.62	1.070	1.36	13.78	2.57	Dark brown, starchy.
	23	12	1124	1	9.5	.8	1.84	1.37	57.80	1.069	1.48	12.53	3.30	Do.
	26	14	1247	1	.8	8	1.45	1.04	58.60	1.072	1.40	13.07	3.30	Do.
	26	10	1248	1	9	8	1.40	1.02	58.82	1.058	1.41	10.45	2.60	Do.

* Not inverted.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Sept. 3	13	1599	1	8.6	0.8	1.76	1.13	63.10	1.068	.78	12.80	2.99	Dark green, starchy.
3	13	1600	1	9.4	.7	1.81	1.06	57.05	1.066	1.17	11.25	3.72	Dark brown, starchy.
17	13	2102	1	8.5	.8	1.48	.84	60.66	1.069	1.67	11.85	3.60	Do.
18	14	2125	1	10.1	.8	1.52	1.21	60.59	1.073	1.19	12.28	4.42	Dark green, starchy.
18	13	2126	1	9.0	.8	1.45	.96	50.91	1.065	1.39	11.21	3.50	Dark brown, starchy.
23	13	2312	1	9.1	.8	1.08	.73	57.03	1.065	1.44	11.90	2.91	Dark brown; some starch.
23	13	2313	1	8.0	.8	1.28	.76	55.78	1.069	1,45	12.36	3.17	Do.
27	13	2521	1	8.1	.7	1.29	.78	54.49	1,060	1.23	11.52	2.20	Dark green, starchy.
27	16	2522	1	9.0	.8	1.72	1.14	57.36	1.078	.92	15.43	3.05	Dark brown, starchy.
Oct. 1	15*	2707	1	6.5	.8	1.30	.95	56.68	1.068	1.64	12.54	2.87	Do.
6	13	2780	2	8.4	.8	2.34	1.50	62.28	1.062	1.33	10.86	3.20	Brown, starchy.
8	15	2868	1	8.4	.8	1.79	1.03	56.62	1.070	1.52	13.27	2.51	Red.
15	16	3027	1	8.8	.8	1.43	1.08	58.98	1.074	.87	14.21	3.81	Light green.
16	15	3064	1	8.0	.7	2.20	1.36	59.84	1.072	1.52	12.68	4.88	Olive.
22	15	3184	1	8.8	.8	1.14	.90	55.64	1.071	1.27	12.82	3.53	Do.
26	18	3248	1	8.7	.8	1.05	.86	52.82	1.085	1.56	16.31	2.54	Dirty green.
Nov. 4	17	3408	1	8.5	.8	1.32	1.05	58.89	1.079	.94	15.07	2.81	Olive.
6	17	3454	1	7.5	.8	.61	.40	60.00	1.079	3.14	12.12	4.05	Olive green.

TABLE No. 7.—BLACK-TOP SORGHUM. D. W. AIKEN, COKESBURY, S. C.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
July 17	1	30	2	5.8	0.8	2.27	1.63	47.07	1.032	2.92	3.88	1.52	
17	2	34	2	6.7	.7	2.39	1.78	52.87	1.024	2.01	3.23	1.81	
20	3	63	2	6.6	.8	2.73	1.97	44.39	1.039	3.88	4.31	1.80	
22	4	112	1	7.4	.9	1.72	1.26	54.93	1.035	1.83	4.84	1.98	
22	5	113	2	6.9	.8	2.86	2.02	46.79	1.043	3.00	5.35	2.29	
22	6	114	1	7.8	.7	1.29	.91	62.65	1.039	2.01	5.82	1.84	
23	7	135	1	8.7	.6	1.21	.89	66.49	1.048	2.06	7.90	2.11	Light green, starchy.
26	8	183	1	7.4	.8	1.66	1.21	59.90	1.046	1.97	7.78	1.48	Do.
26	9	186	2	6.8	.7	1.90	1.32	57.52	1.051	1.31	9.40	2.04	Do.
27	9	230	2	7.2	.6	2.15	1.54	59.13	1.057	1.09	10.05	3.29	Do.
29	9	259	1	7.3	.8	1.97	1.41	66.[illegible]	1.049	1.26	8.25	2.74	Dark green.
30	9	299	1	9.2	.7	1.91	1.43	63.72	1.052	1.96	9.49	1.51	Do.
31	9	341	1	8.1	.6	1.10	.88	63.59	1.067	3.42	10.56	2.80	Light green.
Aug. 3	9	396	1	7.4	.7	1.00	.73	65.30	1.061	1.35	11.36	2.37	Light green, starchy.
4	10	438	1	7.0	.7	1.59	1.16	66.92	1.060	.75	11.70	2.36	Do.
7	10	552	1	6.9	.6	1.07	.74	67.06	1.059	1.31	10.53	2.89	Dark green, watery.
9	9	587	1	8.0	.8	1.88	1.34	64.53	1.065	1.20	12.29	3.04	Dark green, some starch.
19	10	945	1	7.6	.7	1.43	.92	65.02	1.058	1.55	10.39	2.47	Dark green, starchy.
19	10	946	1	7.5	.7	1.72	1.29	58.84	1.076	1.34	14.07	3.50	Do.
19	11	947	1	7.6	.7	1.37	.96	59.70	1.071	.58	13.64	3.38	Do.
19	11	948	1	7.0	.8	1.30	.89	59.75	1.078	.99	13.33	4.78	Do.
23	12	1119	1	7.0	.6	1.15	.76	64.93	1.065	.80	12.55	2.80	Do.
23	12	1120	1	7.8	.9	1.53	1.23	62.14	1.078	.74	14.61	3.85	Do.
26	13	1243	1	7.1	.8	1.45	.88	61.29	1.074	.73	14.89	1.88	Do.
26	13	1244	1	7.2	.6	1.17	.73	60.76	1.069	.94	12.89	2.91	Do.
Sept. 3	15	1595	1	8.3	.7	1.68	1.06	67.01	1.061	.85	11.21	2.93	Do.
3	15	1596	1	8.7	.9	1.99	1.44	60.24	1.079	.52	14.14	4.20	Do.
8	15	1804	1	8.3	.8	2.17	1.23	58.92	1.072	.54	12.82	4.04	Dark green, some starch.
8	15	1805	1	6.6	.7	1.05	.60	61.33	1.071	1.21	13.01	3.14	Do.
17	15	2103	1	7.5	.7	1.43	.81	52.73	1.074	1.22	13.71	2.71	Dark green, starchy.
17	15	2104	1	8.0	.8	1.38	.90	56.72	1.052	1.54	8.74	2.79	Do.
23	16	2308	1	7.4	.8	1.60	.85	63.70	1.064	.52	13.01	2.45	Dark green, some starch.
23	16	2309	1	7.0	.8	1.30	.76	58.79	1.072	.83	13.30	3.08	Do.
27	16	2517	1	6.6	.8	1.28	.74	59.64	1.058	2.30	10.00	1.92	Dark green, starchy.
27	16	2518	1	7.1	.7	1.03	.69	51.74	1.068	1.09	12.75	2.45	Do.
Oct. 1	16*	2709	1	4.8	.8	1.24	.88	54.72	1.068	1.05	13.36	2.59	Green.
6	16	2778	1	9.6	.9	1.57	1.08	59.95	1.071	.84	13.50	3.04	Dark green, starchy.
8	16	2866	1	7.1	.8	1.20	.74	64.28	1.070	1.51	12.04	6.41?	Green.
15	17†	3025	1	9.1	.9	1.99	1.31	59.93	1.077	.46	14.55	4.95	Dark green.
16	17	3062	1	9.0	1.0	1.89	1.11	60.20	1.072	.60	14.33	9.52?	Do.
22	17	3182	1	8.0	.8	1.74	.90	59.80	1.076	.46	15.45	3.75	Do.
26	18	3246	1	8.0	.9	1.50	.97	60.68	1.066	3.17	11.59	1.58	Do.

*Topped August 28. †Topped

ANALYSES OF JUICES FROM SORGHUM—Continued.

TABLE No. 8.—AFRICAN SORGHUM. WILLIAM E. PARKS, CARLISLE, KY.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	In.	Lbs.	Lbs.	Pr. ct.		Pr. ct.	Pr. ct.	Pr. ct.	
July 17	1	33	2	7.5	0.8	2.66	2.07	58.49	1.027	2.92	2.98	1.53	
17	2	37	1	8.4	.9	2.07	1.63	51.74	1.029	4.25	1.76	1.84	
19	3	40	2	8.5	.9	3.85	3.00	38.15	1.031	4.67	1.73	1.34	
19	4	41	2	8.8	.7	2.33	1.82	46.59	1.042	2.40	6.18	1.77	
23	4	131	1	8.0	.8	1.89	1.53	52.98	1.030	4.10	1.87	1.65	Light green.
24	5	50	1	8.6	.7	1.34	1.03	52.40	1.037	5.49	2.21	.64	Do.
23	5	132	1	9.1	.7	1.28	.98	61.12	1.049	3.26	5.47	1.66	Do.
21	6	81	2	8.7	.7	3.05	2.33	47.45	1.044	3.62	5.66	1.97	Do.
23	7	126	1	8.8	.7	1.51	1.17	52.63	1.041	3.85	4.67	1.52	Do.
26	8	174	1	7.7	.7	1.43	1.05	56.62	1.054	2.67	8.96	2.32	Dark green.
27	9	225	1	7.4	.7	1.23	.90	60.27	1.049	3.16	6.89	2.53	Lighter green, starchy.
31	9	325	1	8.8	.8	1.59	1.23	64.63	1.061	1.42	11.13	2.72	Dark green, starchy.
29	10	252	1	11.5	.8	1.94	1.43	48.00	1.052	1.58	7.78	3.34	Do.
30	10	286	1	8.6	.9	1.75	1.33	61.88	1.066	1.92	10.05	4.65	Do.
Aug. 2	10	358	1	8.6	.7	1.27	1.04	65.25	1.066	2.19	11.26	2.87	Light green, starchy.
4	10	429	1	7.0	.7	1.22	.85	69.74	1.034	3.23	3.86	1.52	Do.
6	10	512	1	9.6	1.1	1.94	1.56	68.21	1.060	2.64	10.24	2.43	Dark green, starchy.
7	10	540	1	9.2	.6	1.30	1.01	65.43	1.058	2.87	9.36	2.33	Do.
9	11	574	1	8.6	.6	.97	.76	32.46	1.066	1.45	12.21	2.98	Do.
4	9	445	1	8.2	.7	1.16	.96	59.47	1.068	1.02	13.12	2.71	Light green, starchy.
4	9	446	1	9.0	.8	1.61	1.18	68.03	1.066	.76	12.48	2.94	Do.
4	9	447	1	9.3	.7	1.60	1.17	62.88	1.066	1.30	12.27	2.65	Do.
4	9	448	1	9.1	.7	1.44	1.17	63.72	1.062	.82	11.81	2.62	Do.
10	9	614	1	8.4	.8	1.30	.97	67.50	1.055	1.20	9.82	1.88	Light green, watery.
10	9	615	1	8.6	.9	1.86	1.35	62.61	1.070	1.12	13.39	2.64	Light green, starchy.
10	9	616	1	9.7	.8	1.93	1.49	66.71	1.067	1.34	12.30	2.73	Do.
10	9	617	1	8.0	.9	1.57	1.14	66.34	1.068	2.66	10.01	2.08	Do.
13	11	740	1	8.9	.7	1.46	1.03	68.52	1.065	3.40	10.46	2.10	Do.
13	11	741	1	8.4	.8	1.25	.94	71.56	1.065	1.17	12.63	1.96	Do.
18	11	742	1	9.0	.6	1.34	.95	69.07	1.057	.96	10.77	2.22	Do.
18	11	743	1	8.0	.9	1.50	1.21	69.18	1.056	.74	10.60	2.20	Do.
17	11	871	1	9.6	.8	1.71	1.26	62.5[illegible]	1.073	.72	12.85	4.04	Dark green, starchy.
17	11	872	1	9.1	.8	1.54	1.25	66.14	1.075	1.20	13.39	3.74	Do.
17	11	873	1	10.6	1.0	2.11	1.79	66.87	1.077	1.02	13.20	4.40	Do.
17	11	874	1	8.6	.8	1.40	1.08	64.59	1.078	.51	14.67	3.56	Do.
21	12	1052	1	7.5	.8	1.66	1.25	66.67	1.061	2.21	10.36	2.93	Do.
21	12	1053	1	9.0	.8	1.28	.97	57.40	1.064	1.64	11.25	3.37	Do.
21	12	1054	1	8.3	.9	1.51	1.16	65.71	1.062	3.61	9.48	2.43	Do.
21	12	1055	1	7.6	.8	1.38	.99	63.93	1.063	1.59	11.00	2.81	Do.
24	13	1183	1	9.0	.9	2.35	1.65	64.67	1.069	2.71	11.62	2.65	Do.
24	13	1184	1	8.0	1.0	1.97	1.42	60.05	1.063	2.56	10.30	2.67	Do.
24	13	1185	1	8.5	.9	2.08	1.38	69.11	1.044	1.46	7.60	2.10	Do.
24	13	1186	1	8.5	.9	1.89	1.41	63.91	1.078	.68	14.55	3.88	Do.
27	14	1315	1	9.4	.9	2.32	1.61	63.28	1.074	.75	13.55	4.04	Do.
27	14	1316	1	8.2	.9	1.62	1.17	66.63	1.057	2.31	9.45	3.45	Do.
27	14	1317	1	9.1	.9	1.67	1.25	67.01	1.064	1.82	11.28	3.74	Do.
27	14	1318	1	9.0	1.0	2.29	1.64	65.32	1.071	.87	12.92	3.81	Do.
Sept. 1	15	1535	1	6.5	.7	1.06	.73	64.16	1.050	3.37	6.86	2.20	Dark green, some starch.
1	15	1536	2	7.5	.7	2.49	1.57	49.93	1.061	1.40	10.94	3.12	Do.
1	15	1537	1	7.0	.9	1.72	1.19	54.63	1.060	1.53	10.44	2.60	Do.
1	15	1538	1	8.1	.9	1.65	1.27	60.24	1.074	.86	13.40	3.02	Do.
4	15	1684	1	9.5	.9	1.87	1.34	60.59	1.071	1.21	12.35	3.80	Dark green, starchy.
4	15	1685	1	8.6	.9	1.67	.90	62.83	1.058	.59	11.00	2.92	Do.
4	15	1686	1	9.3	.8	1.75	1.31	62.18	1.072	1.03	12.98	3.76	Do.
4	15	1687	1	7.1	.7	1.00	.73	64.85	1.046	3.42	6.51	2.35	Dark brown, starchy.
9	16	1884	1	9.5	.7	1.69	1.20	55.33	1.087	.77	12.04	3.59	Dark green, starchy.
9	16	1885	1	10.0	1.0	2.31	1.74	64.14	1.074	.55	13.75	3.90	Do.
9	16	1886	1	9.7	.9	1.61	1.17	64.91	1.068	.50	11.91	3.88	Do.
9	16	1887	1	9.0	.7	1.47	.98	61.57	1.068	.99	11.58	3.39	Do.
17	16	2078	1	10.1	1.2	3.08	2.17	68.67	1.081	.79	16.00	2.96	Do.
17	16	2079	1	9.0	1.0	1.47	1.31	60.94	1.075	1.08	14.32	2.30	Do.
17	16	2080	1	10.0	1.0	2.59	1.51	63.66	1.072	.74	13.00	3.84	Do.
17	16	2081	1	9.0	1.1	2.55	1.69	63.27	1.076	.79	12.72	4.92	Do.
20	16	2192	1	7.1	.8	1.60	.98	64.71	1.052	.62	9.75	2.70	Do.
20	16	2193	1	10.2	1.1	2.55	1.50	59.83	1.072	.79	13.65	3.52	Do.
20	16	2194	1	6.6	.9	1.31	1.09	62.27	1.075	.91	14.37	3.42	Do.
20	16	2195	1	7.6	.9	2.05	1.23	53.50	1.074	.49	13.69	4.08	Do.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Sept. 24	16	2423	1	8.1	0.9	1.78	.88	66.25	1.079	.72	14.66	3.84	Dark green, starchy.
24	16	2424	1	7.0	.8	1.15	.71	59.89	1.072	1.07	12.95	3.38	Do.
24	16	2525	1	9.4	.8	1.47	.92	61.24	1.065	.76	12.12	3.08	Do.
24	16	2426	1	6.2	.8	.67	.45	61.95	1.034	2.36	9.13	2.37	Do.
28	16	2606	1	8.8	.9	2.14	1.15	58.62	1.069	.89	12.58	3.27	Thin, watery.
28	16	2607	1	10.5	.9	2.24	1.50	63.48	1.074	.58	14.20	2.99	Do.
28	16	2608	1	9.1	.8	1.28	.91	60.04	1.070	2.77	11.97	2.22	Do.
28	16	2609	1	7.5	.8	1.68	1.03	57.02	1.076	.81	14.72	2.73	Do.
Oct. 1	16*	2695	1	7.8	1.0	1.56	1.28	65.04	1.073	1.18	13.56	3.48	Dark green.
4	16	2745	1	8.3	1.0	2.31	1.50	63.73	1.074	.71	14.59	3.42	Very light green.
7	16	2813	1	8.0	.8	1.19	.72	60.39	1.068	1.12	12.50	2.91	
11	16	2905	1	7.3	.8	1.52	1.06	58.68	1.081				
13	16	2975	1	8.1	.6	1.12	.66	58.00	1.073	......	......	......	Dark green.
15	17	3004	2	8.8	.7	1.67	1.35	60.49	1.076	.68	12.97	3.77	Dark olive.
16	17	3044	1	8.6	.8	1.12	.82	67.38	1.076	1.57	13.35	4.92	Dark green.
19	17	3101	1	8.9	.9	1.65	1.20	52.93	1.075	.55	14.04	4.18	Do.
20	17	3128	1	7.5	1.1	1.86	1.41	59.80	1.070	1.72	13.11	3.77	Dark olive.
22	17	3163	1	9.4	.8	.99	.85	54.55	1.092	1.32	12.72	3.95	Do.
25	17	3218	1	7.9	.8	1.18	.90	59.02	1.072	2.75	14.76	4.70	Dirty green.
27	17	3274	1	9.7	.9	1.42	1.05	55.04	1.083	1.14	13.10	3.48	Do.
29	17	3313	1	7.4	.8	1.29	.91	63.77	1.075	1.54	15.31	3.32	Dark green.
30	18	3343	1	9.0	.9	1.86	1.21	64.00	1.068	1.08	12.96	3.45	Dirty green.
Nov. 3	18	3392	1	7.3	.9	1.01	.77	56.29	1.062	1.40	12.68	3.10	Light green.
5	18	3428	1	8.2	.6	1.03	.89	61.82	1.072	1.32	9.92	3.92	Olive.
9	18	3482	1	8.0	.9	1.43	.96	63.01	1.071	1.53	13.55	3.15	Dark green.
12	18	3506	1	9.3	.6	1.16	.94	61.65	1.070	1.72	12.30	3.11	Dirty green.
15	18	3536	1	8.0	1.0	1.35	1.18	68.79	1.068	1.52	11.83	3.02	Brown.
										2.53	11.77	2.48	Light olive.

TABLE NO. 9.—WHITE MAMMOTH. E. LINK, GREENEVILLE, TENN.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
Aug. 2	1	369	1	8.7	0.8	1.64	1.32	70.98	1.031	2.95	3.05	2.10	Light green.
3	2	397	1	8.9	.8	1.63	1.32	71.33	1.033	3.03	3.88	1.71	Light green, starchy.
4	2	439	1	9.3	.7	1.79	1.45	73.23	1.031	2.81	3.57	1.77	Do.
9	3	588	1	9.9	.7	1.75	1.41	69.84	1.042	2.68	6.13	2.23	Dark green, watery.
18	4	933	1	8.4	.6	.86	.66	66.67	1.048	3.22	6.89	2.01	Dark green, starchy.
18	4	934	1	9.4	.5	.80	.62	68.02	1.050	2.98	7.40	2.14	Do.
18	4	935	1	8.8	.5	.85	.67	66.11	1.051	3.04	7.58	2.08	Do.
18	4	936	1	8.4	.6	.81	.64	68.96	1.045	3.28	6.39	1.86	Do.
23	7	1125	2	9.5	.7	2.75	2.21	69.15	1.058	2.47	10.17	2.01	Do.
23	7	1126	1	9.4	.7	1.25	.94	66.98	1.052	3.41	8.30	1.60	Do.
23	7	1127	2	8.5	.8	2.18	1.70	66.98	1.055	3.15	9.36	1.57	Do.
23	7	1128	1	10.0	.8	1.52	1.21	68.89	1.057	2.50	9.99	2.17	Do.
26	8	1249	1	10.5	.9	1.76	1.41	68.98	1.049	2.13	8.27	2.04	Do.
26	8	1250	1	9.5	.8	1.49	1.63	69.87	1.059	2.44	10.02	2.03	Do.
26	9	1251	1	10.0	.9	2.26	1.09	65.72	1.053	1.96	9.30	1.99	Do.
26	9	1252	1	10.4	.9	1.82	1.35	70.41	1.061	1.93	10.45	2.61	Do.
Sept. 3	10	1601	1	10.4	.8	1.50	1.23	68.95	1.055	1.48	10.43	2.31	Do.
3	10	1602	1	9.6	.8	1.74	1.36	69.35	1.060	1.59	10.61	2.71	Do.
3	10	1606	1	9.7	1.0	2.09	1.70	68.56	1.064	1.79	11.41	2.87	Do.
3	10	1607	1	9.7	1.0	1.71	1.36	66.12	1.067	1.69	12.65	2.44	Do.
8	11	1806	1	9.4	.7	1.73	1.35	52.77	1.060	1.43	11.41	2.21	Dark green, some starch.
8	11	1807	1	9.8	.8	1.84	1.56	66.80	1.069	1.41	12.94	2.68	Do.
8	11	1813	1	9.0	.9	1.63	1.36	61.00	1.072	1.70	12.33	3.80	Do.
8	11	1814	1	9.3	.9	1.71	1.37	47.51	1.073	1.29	12.81	1.19	Do.
18	12	2127	2	10.0	.8	3.04	2.49	62.28	1.072	.90	12.24	4.54	Dark green, starchy.
18	12	2128	1	9.8	.9	2.02	1.73	61.65	1.072	1.11	12.45	4.40	Do.
18	12	2129	1	9.3	.8	1.52	1.30	60.00	1.070	1.40	12.54	3.68	Do.
18	12	2130	1	10.0	.9	2.21	1.92	62.89	1.073	1.16	11.87	5.38	Do.
23	13	2314	1	10.6	.9	1.73	1.53	62.59	1.066	1.10	12.94	2.28	Dark green, some starch.
23	13	2315	1	9.3	.9	1.81	1.44	51.52	1.069	.95	13.45	2.53	Do.
23	13	2316	1	9.3	1.0	1.83	1.54	61.90	1.082	.80	15.42	3.47	Do.
23	13	2317	1	10.0	1.0	2.09	1.73	63.70	1.080	.88	13.90	4.48	Do.
23	13	2316	....	......	....	......	......	......	1.075	.93	14.36	2.94	Do.
27	14	2523	1	10.0	.9	1.81	1.49	58.27	1.082	.73	15.55	3.50	Dark green, starchy.
27	14	2524	1	10.3	.9	1.98	1.65	63.73	1.077	.93	14.91	7.42?	Do.
27	14	2525	1	8.8	.9	1.51	1.21	63.38	1.078	1.00	15.09	3.02	Do.
27	14	2526	1	9.7	.9	1.82	1.50	62.42	1.081	.88	16.15	2.95	Do.

*Topped August 28.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Oct. 1	15*	2710	1	8.5	0.8	1.60	1.46	63.44	1.076	1.89	13.83	5.47	Green.
6	15	2781	1	10.0	.9	1.61	1.34	58.97	1.082	.59	15.68	3.59	Dark green, starchy.
8	15	2869	1	10.0	.8	1.76	1.48	65.77	1.073	.91	13.57	3.37	Green.
12	15	2940	1	9.7	.9	1.91	1.50	64.71	1.080	.94	14.28	4.03	Light green, starchy.
14	15	3002	1	9.3	.9	1.87	1.51	60.29	1.090	1.15	16.12	4.39	Dark green.
15	13	3028	1	10.5	.7	1.56	1.23	66.07	1.072	.79	13.54	3.82	Do.
16	16	3066	1	10.0	.9	2.01	1.51	63.95	1.079	1.55	7.22?	11.03?	Light green.
22	16	3186	1	10.4	.9	1.69	1.36	61.34	1.078	.71	15.04	2.81	Olive.
26	16	3250	1	9.3	.9	1.86	1.24	62.30	1.081	1.30	15.08	3.44	Dark green.
Nov. 4	17	3409	1	9.0	1.3	1.69	1.56	61.27	1.075	.62	14.39	3.16	Do.
6	17	3455	1	9.0	1.0	2.33	2.00	64.40	1.071	1.10	13.13	3.46	Do.

TABLE No. 10.—OOMSEEANA. BLYMYER & CO., CINCINNATI, OHIO.

July 15	1	16	2	6.3	0.6	......	1.82	81.60	1,023	2.84	1.55	2.30	
15	2	12	2	5.7	.8	......	1.32	51.83	1.030	4.82	1.46	.99	
20	3	56	1	9.9	.7	1.19	1.07	58.60	1.027	2.85	2.26	1.79	
21	4	79	2	7.4	.8	2.32	1.82	57.10	1.030	3.03	2.71	1.98	
21	5	80	2	7.2	.8	2.86	2.22	42.80	1.035	2.57	4.33	1.84	
22	6	93	1	8.6	.8	1.63	1.18	60.06	1.039	1.76	6.23	1.97	
24	6	138	1	7.7	.9	1.64	1.21	70.53	1.032	4.14	2.28	1.82	Light green.
22	7	94	1	6.4	.8	1.56	1.16	65.20	1.030	3.88	3.19	1.67	
24	7	139	1	8.4	.7	1.40	.97	60.25	1.035	3.48	3.35	2.40	Light green.
23	8	122	1	9.4	.8	1.93	1.50	58.88	1.041	2.11	6.29	2.02	Do.
26	9	160	1	10.7	1.1	2.84	2.31	59.61	1.037	2.83	4.35	1.74	Dark green.
27	9	217	1	9.7	.9	2.16	1.56	65.44	1.042	3.42	4.66	2.86	Do.
28	10	244	1	9.5	.7	1.38	1.16	62.40	1.047	.96	8.10	2.78	Dark green, starchy.
30	10	280	1	8.2	.9	2.17	1.71	63.23	1.050	3.21	6.56	2.71	Do.
31	10	317	1	7.4	.6	1.18	.90	66.34	1.051	2.53	8.10	2.36	Do.
Aug. 2	10	351	1	9.3	.7	1.30	1.01	67.69	1.055	3.00	8.30	1.88	Light green, starchy.
4	10	424	1	6.7	.7	1.25	.86	65.82	1.041	1.69	6.38	2.06	Dark green, starchy.
6	9	506	1	8.5	1.1	1.69	1.28	65.06	1.059	3.02	9.02	2.59	Do.
7	10	530	1	7.5	.9	1.76	1.36	79.42?	1.049	2.09	7.69	2.57	Light green, starchy.
9	9	507	1	8.0	1.0	2.42	1.78	68.56	1.053	3.46	7.88	2.29	Do.
5	10	457	1	7.2	.9	1.09	.79	70.87	1.033	2.38	3.55	2.44	Dark green, starchy.
5	10	458	1	9.4	1.0	1.45	1.16	67.30	1.057	1.15	9.96	3.18	Do.
5	10	459	1	9.0	.9	1.41	1.13	68.62	1.061	2.16	9.81	3.11	Do.
5	10	460	1	8.0	1.1	1.78	1.25	69.30	1.054	1.75	8.81	2.82	Do.
10	10	630	1	9.0	.7	1.54	1.22	64.14	1.068	.88	13.52	2.38	Do.
10	10	631	1	8.2	.8	1.27	1.02	67.53	1.061	1.91	10.94	2.28	Do.
10	10	632	1	7.8	.6	.98	.72	91.79?	1.054	3.47	8.39	1.19	Do.
10	10	633	1	7.6	.9	1.42	1.01	64.10	1.052	3.09	7.25	2.35	Do.
12	10	711	1	7.5	.9	1.56	1.18	68.66	1.046	2.66	7.17	1.50	Do.
12	10	712	1	8.2	.9	1.58	1.10	81.57?	1.051	2.71	8.20	1.84	Do.
12	10	713	1	9.1	1.0	1.75	1.39	72.06	1.057	3.31	7.53	3.40	Do.
12	10	714	1	7.7	.9	1.74	1.17	67.79	1.053	2.83	7.80	2.43	Do.
16	10	841	1	7.8	.8	1.49	.95	69.12	1.035	2.45	4.42	2.02	Do.
16	10	842	1	8.2	1.0	1.82	1.34	52.29	1.045	3.44	6.30	1.36	Do.
16	10	843	1	8.9	.9	1.88	1.03	69.09	1.057	1.62	10.21	1.99	Do.
16	10	844	1	8.1	.8	1.90	1.46	65.65	1.062	1.08	11.30	2.36	Do.
20	11	1013	1	7.9	.8	1.29	.98	69.66	1.058	.63	11.38	2.55	Do.
20	11	1014	1	8.9	.8	1.51	1.17	67.55	1.062	2.10	11.09	2.63	Do.
20	11	1015	1	7.5	1.0	1.84	1.25	68.46	1.056	.96	9.99	3.11	Do.
20	11	1016	1	8.2	1.0	1.69	1.27	68.70	1.042	3.19	5.50	2.25	Do.
24	12	1155	1	8.6	.9	1.96	1.36	64.51	1.065	1.64	12.41	2.01	Do.
24	12	1156	1	8.6	.8	1.70	1.24	70.91	1.074	.80	14.97	2.53	Do.
24	12	1157	1	7.1	.9	1.51	1.10	65.63	1.065	1.25	12.27	2.30	Do.
24	12	1158	1	8.5	.9	1.88	1.35	65.08	1.065	3.05	10.01	3.04	Do.
26	13	1284	1	9.0	1.0	1.99	1.38	66.06	1.060	2.15	10.21	2.26	Do.
26	13	1285	1	10.0	.9	1.56	1.28	59.95	1.075	1.40	13.26	3.63	Do.
26	13	1286	1	7.6	1.0	1.77	1.28	68.10	1.062	.53	11.75	2.64	Do.
26	13	1287	1	8.6	.7	1.77	1.17	67.23	1.068	2.53	10.51	2.98	Do.
Sept. 1	14	1507	1	8.2	.8	1.66	1.25	53.86	1.076	.76	14.18	3.88	Dark green, some starch.
1	14	1508	1	8.5	.7	1.51	1.07	Lost.	1.071	.65	13.44	3.65	Do.
1	14	1509	1	8.2	.8	1.52	1.16	63.80	1.070	.64	13.48	3.54	Do.
1	14	1510	1	9.1	.8	1.83	1.41	65.31	1.070	1.02	13.04	3.42	Do.
4	14	1651	1	6.6	.6	.83	.62	64.00	1.036	2.65	4.50	1.83	Dark green, starchy.

*Topped August 28.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	In.	Lbs.	Lbs.	Pr. ct.		Pr. ct.	Pr. ct.	Pr. ct.	
Sept. 4	14	1652	1	8.6	0.9	1.95	1.36	61.69	1.064	.92	12.79	1.70	Dark green, starchy.
4	14	1653	1	7.3	.7	1.28	.89	64.77	1.060	2.89	9.94	2.08	Do.
4	14	1654	1	7.0	.9	1.30	.90	64.87	1.054	2.64	9.09	2.03	Do.
9	15	1856	1	8.4	.9	2.22	1.60	64.41	1.068	1.44	13.38	1.66	Dark green, some starch.
9	15	1857	1	8.6	.9	1.59	1.06	62.86	1.064	2.88	11.22	2.64	Do.
9	15	1858	1	8.4	.9	1.72	1.20	64.10	1.063	1.23	11.38	2.96	Dark brown, starchy.
9	15	1859	1	10.0	1.0	2.21	1.59	63.66	1.074	.90	12.35	5.05	Dark green, starchy.
16	15	2047	1	7.8	.8	1.44	1.04	63.50	1.055	2.20	9.16	2.20	Dark brown, starchy.
16	15	2048	1	9.1	.7	1.65	1.13	60.19	1.065	.73	11.60	3.07	Dark green, starchy.
16	15	2049	1	9.6	.9	1.92	1.49	63.72	1.082	.81	14.95	3.56	Do.
16	15	2050	1	8.9	1.0	2.24	1.76	65.59	1.072	1.15	13.21	2.90	Do.
20	16	2164	1	9.5	1.0	2.46	1.73	60.38	1.076	1.58	14.51	2.82	Do.
20	16	2165	1	7.9	.9	1.29	.92	62.50	1.066	.70	12.92	2.70	Do.
20	16	2166	1	7.8	.9	1.47	1.04	62.70	1.066	1.14	12.38	2.90	Do.
20	16	2167	1	10.0	1.0	2.11	1.56	62.20	1.075	.79	14.27	3.45	Do.
24	16	2395	1	11.2	.8	1.54	1.15	61.83	1.075	.74	12.77	4.77	Dark green, some starch.
24	16	2396	1	8.0	.9	1.52	.97	62.25	1.063	1.05	11.40	3.59	Do.
24	16	2397	1	9.0	.9	1.96	1.34	61.26	1.062	.64	11.45	3.30	Do.
24	16	2398	1	8.1	.9	2.02	1.17	61.28	1.081	.59	14.44	4.91	Do.
27	16	2558	1	6.5	.8	1.01	.63	69.21	1.047	.72	7.37	3.28	Dark green, starchy.
27	16	2559	1	10.0	1.0	1.72	1.36	62.58	1.068	.43	12.26	3.97	Do.
27	16	2560	1	9.7	.8	1.43	1.04	61.93	1.071	.47	13.26	3.54	Do.
27	16	2561	1	7.3	.9	1.54	.98	62.86	1.071	.94	13.19	3.28	Do.
30	16*	2688	1	7.5	1.2	2.20	2.12	64.65	1.075	1.29	14.33	2.94	Do.
Oct. 4	16	2738	1	9.8	.8	1.42	1.04	60.38	1.082	1.12	15.51	3.98	Do.
6	16	2793	1	8.8	1.0	1.47	1.01	68.34	1.072	1.33	12.65	3.58	Do.
11	16	2898	1	7.3	.9	1.65	.95	66.82	1.074	......	......	......	Do.
13	16	2968	1	8.6	.8	1.18	.72	60.97	1.080	1.13	14.05	3.73	Dark olive.
14	17	2994	1	8.5	.9	1.08	.94	66.82	1.071	1.11	13.18	3.09	Dark green.
15	17	3036	1	8.9	.8	1.16	.73	60.00	1.072	2.59	13.05	2.27	Do.
17	17	3092	1	9.4	.8	1.36	1.01	64.35	1.071	3.12	11.83	3.21	Do.
19	17	3118	1	6.1	.8	1.10	.70	61.56	1.071	1.14	12.61	3.30	Do.
21	18	3151	1	9.4	.9	1.32	1.13	60.89	1.076	.55	13.82	5.01	Light green.
25	17	3211	1	8.9	.8	1.01	.85	60.88	1.064	2.70	10.38	3.65	Dirty light green.
27	18	3267	1	11.0	1.2	2.29	1.71	70.06	1.085	.78	14.97	5.14	Dark green.
28	18	3305	1	8.8	1.0	1.56	1.17	60.90	1.084	1.40	12.59	6.54	Dirty green.
30	17	3336	1	6.4	.9	.97	.84	68.55	1.057	1.67	8.47	1.78	Do.
2	18†	3381	1	......	1.0	......	1.69	66.32	1.076	2.27	13.08	3.12	Dark green.
6	18	3449	1	8.7	.8	1.26	.92	63.55	1.074	.59	14.19	3.33	Do.
8	18	3464	1	9.5	.9	1.89	1.44	60.03	1.083	.85	15.00	3.90	Do.
9	18	3475	1	9.3	.8	1.06	1.02	67.03	1.062	.59	11.63	3.27	Do.
10	18	3496	1	9.0	.8	.95	.77	65.80	1.065	2.22	10.54	3.69	Olive.
13	18	3530	1	9.5	.9	1.67	1.35	64.23	1.079	1.52	13.75	Lost.	Dark green.

TABLE NO. 11.—REGULAR SORGO. BLYMYER & CO., CINCINNATI, OHIO.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
July 19	1	46	2	7.5	1.0	3.45	2.61	45.48	1.030	4.76	1.07	2.66	
20	2	65	1	7.5	.9	2.05	1.46	57.10	1.031	2.97	3.18	1.39	
22	3	100	1	9.3	1.1	2.63	2.13	59.28	1.030	4.64	.55	2.38	
24	3	145	2	8.7	.9	3.51	2.66	47.64	1.033	3.90	2.53	2.09	Light green.
22	4	101	1	9.4	.9	2.20	1.60	55.32	1.035	4.58	.26	4.38	
24	4	146	2	9.2	.9	3.90	3.03	45.84	1.032	4.51	2.18	1.59	Darker green.
23	5	127	1	7.5	.8	1.56	1.27	46.25	1.042	3.75	4.62	1.95	Light green.
23	6	128	1	9.2	.7	1.02	.74	56.74	1.044	3.45	5.55	2.40	Light green, starchy.
26	7	175	1	8.2	.8	1.14	.99	56.67	1.045	4.01	5.97	.35	Dark green, starchy.
29	7	255	1	9.7	1.0	2.13	1.71	64.41	1.056	3.27	8.09	.57	Do.
29	8	253	1	9.2	.9	1.78	1.33	63.70	1.051	3.64	6.37	2.69	Do.
30	9	287	1	10.0	.8	1.91	1.50	64.90	1.055	3.71	7.42	2.61	Do.
31	9	326	1	9.5	.8	1.45	1.12	68.37	1.054	3.56	7.10	2.95	Do.
Aug. 2	10	359	1	9.2	.9	1.75	1.34	67.76	1.058	3.18	8.84	3.01	Light green, starchy.
4	9	430	1	9.2	.8	.90	.60	50.18	1.060	1.80	10.76	2.06	Do.
6	9	513	1	10.5	.9	1.66	1.30	64.24	1.059	2.81	9.11	2.91	Dark green, starchy.
7	10	541	1	8.0	.7	1.09	.82	65.59	1.060	2.81	9.58	2.52	Light green, watery.
9	9	575	1	10.0	1.0	2.15	1.62	65.44	1.057	2.81	9.28	2.48	Dark green, starchy.
4	9	449	1	8.6	.7	1.29	.97	70.59	1.052	2.73	8.10	2.05	Light green, starchy
4	9	450	1	8.8	.8	1.65	1.19	66.05	1.057	3.05	8.67	2.57	Do.

* Topped August 28. † Stripped and topped.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Aug. 4	9	451	1	10.2	0.9	1.36	1.09	49.70	1.060	1.33	10.77	2.76	Light green, starchy.
4	9	452	1	9.7	.8	1.66	1.28	67.01	1.052	3.51	7.68	1.88	Do.
13	9	744	1	11.3	1.2	2.45	1.95	69.38	1.060	2.20	10.63	2.31	Dark green, starchy.
13	9	745	1	9.8	1.0	2.00	1.57	65.94	1.067	2.28	11.82	2.58	Do.
13	9	746	1	9.5	.9	1.31	.80	45.75	1.069	.56	12.64	3.55	Do.
13	9	747	1	9.0	1.0	1.75	1.40	59.50	1.070	1.30	13.31	2.59	Do.
17	10	875	1	9.6	.9	1.85	1.36	65.07	1.065	2.24	11.35	2.37	Do.
17	10	876	1	10.0	1.0	1.96	1.49	63.78	1.067	1.74	13.30	1.27	Do.
17	10	877	1	10.6	.9	1.88	1.43	62.31	1.063	2.20	11.13	2.19	Do.
17	10	878	1	9.9	1.0	1.80	1.37	62.52	1.067	.88	12.67	2.80	Do.
21	11	1056	1	10.6	.8	1.29	.81	51.21	1.058	1.44	10.19	2.83	Do.
21	11	1057	1	9.2	1.0	2.03	1.41	69.84	1.056	2.13	9.44	2.49	Do.
21	11	1058	1	10.2	.9	1.74	1.34	62.29	1.062	1.74	10.62	3.04	Do.
21	11	1059	1	10.0	1.0	1.63	1.07	67.93	1.050	1.90	7.65	2.88	Do.
25	11	1189	1	10.0	.9	1.55	1.09	69.29	1.056	1.16	10.58	2.09	Do.
25	11	1190	1	9.3	.9	1.56	1.09	63.84	1.060	1.71	11.21	1.84	Do.
25	11	1191	1	9.9	1.0	1.86	1.35	66.50	1.063	2.27	10.87	2.48	Do.
25	11	1192	1	9.5	.9	1.37	.92	64.63	1.065	2.75	11.37	2.08	Do.
27	12	1319	1	10.0	1.1	2.12	1.55	62.83	1.068	1.35	12.11	3.58	Do.
27	12	1320	1	8.8	.9	1.76	1.19	61.00	1.058	1.56	10.06	2.98	Do.
27	12	1321	1	9.3	.8	1.24	.92	66.18	1.063	1.36	10.81	2.67	Do.
27	12	1322	1	9.1	.8	1.08	1.76	50.00	1.063	1.28	10.22	3.02	Do.
28	13	1341	1	9.6	1.0	2.13	1.64	62.92	1.065	1.63	11.61	2.91	Do.
28	13	1342	1	9.1	.9	1.50	1.00	59.80	1.070	.64	12.53	4.13	Do.
28	13	1343	1	9.9	.9	1.19	.65	46.46	1.065	1.02	10.91	4.17	Do.
28	13	1344	1	8.8	.8	1.30	.88	65.75	1.069	1.78	12.36	3.31	Do,
28	14	1345	1	10.0	.9	2.15	1.38	66.98	1.063	1.68	11.59	2.77	Do.
28	14	1346	1	9.4	.9	1.66	1.20	65.99	1.069	1.03	12.68	2.84	Do.
28	14	1347	2	9.4	.8	3.96	2.70	60.22	1.071	1.28	12.91	3.74	Do.
28	14	1348	1	9.5	.9	1.75	1.21	67.02	1.072	1.14	13.81	3.10	Do.
Sept. 2	13	1541	1	10.4	1.0	2.20	1.71	55.89	1.064	1.16	11.95	2.59	Do.
2	13	1542	1	10.0	.8	1.67	1.19	61.29	1.066	1.11	11.95	2.93	Do.
2	13	1543	1	8.8	.7	1.00	.77	57.87	1.058	1.75	10.06	2.41	Dark green, some starch.
2	13	1544	1	8.6	.7	1.38	.89	63.11	1.060	1.62	10.85	1.92	Do.
6	14	1693	1	8.7	.7	1.45	1.00	35.82	1.072	1.00	13.45	4.21	Dark green, starchy.
6	14	1694	1	9.8	.9	1.50	1.10	66.00	1.060	1.03	11.18	2.79	Do.
6	14	1695	1	9.0	.6	1.15	.83	53.82	1.068	1.10	12.59	3.26	Do.
6	14	1696	1	9.3	.8	1.54	.96	57.24	1.070	1.11	13.13	2.86	Dark brown, starchy.
9	15	1888	1	9.2	.9	2.68	1.39	58.25	1.067	1.01	12.11	2.81	Dark green, starchy.
9	15	1889	1	10.0	1.2	2.66	2.07	61.59	1.069	1.04	12.19	2.98	Do.
9	15	1890	1	10.1	1.1	2.24	1.42	68.01	1.062	1.94	10.90	1.70	Do.
9	15	1891	1	8.5	1.0	2.00	1.24	63.01	1.065	1.64	11.86	2.84	Do.
17	16	2082	1	9.0	1.0	2.12	1.28	59.66	1.067	1.20	12.66	2.78	Do.
17	16	2083	1	10.0	1.3	2.63	1.98	62.33	1.072	1.01	13.71	3.28	Do.
17	16	2084	1	10.4	1.1	2.47	1.62	50.08	1.067	1.19	12.98	2.75	Do.
17	16	2085	1	10.0	1.0	1.97	1.28	61.16	1.071	.90	14.00	2.79	Do.
20	16	2106	1	10.9	1.2	2.79	1.93	61.25	1.070	1.41	13.14	2.83	Do.
20	16	2107	1	10.6	1.0	1.74	1.33	57.66	1.076	.76	14.03	......	Do.
20	16	2108	1	8.7	1.0	1.64	1.15	44.25	1.067	.85	12.44	3.35	Do.
20	16	2109	1	8.7	1.0	1.76	.84	84.51?	1.065	1.58	11.11	3.60	Do.
24	16	2427	1	10.0	1.0	1.85	1.21	56.90	1.071	.79	12.73	4.36	Do.
24	16	2428	1	9.5	1.0	1.37	1.10	64.27	1.055	1.39	9.44	2.77	Do.
24	16	2429	1	10.0	1.0	2.20	1.61	64.93	1.067	1.27	12.49	3.16	Do.
24	16	2420	1	10.0	1.0	1.93	1.27	61.24	1.073	1.14	13.41	3.30	Do.
28	16	2610	1	7.7	.8	1.54	.93	49.76	1.064	1.34	11.36	2.71	Thin, watery.
28	16	2611	1	8.0	1.0	2.79	1.58	61.42	1.074	.92	13.96	2.99	Do.
28	16	2612	1	10.5	1.0	2.05	1.67	62.99	1.064	1.64	10.33	3.68	Do.
28	16	2613	1	8.8	.9	1.51	1.10	54.21	1.064	1.55	11.94	2.30	Dark brown, starchy.
Oct. 1	16*	2696	1	8.4	.9	1.77	1.16	66.47	1.070	1.50	12.65	3.24	Dark green.
4	16	2746	1	9.4	1.2	2.93	1.60	59.47	1.070	.26	13.58	3.60	Greenish brown.
7	16	2814	1	9.0	.9	1.65	1.02	69.91	1.063	1.75	10.31	3.07	Green.
11	16	2906	1	9.6	1.0	2.40	1.45	61.40	1.070	......	......	......	Dark green.
13	16	2976	1	10.0	1.0	2.59	1.85	65.52	1.077	1.24	14.04	3.19	Light green.
15	17	3008	1	10.0	.9	2.09	1.20	52.56	1.079	1.18	12.74?	6.51?	Do.
16	17	3045	1	9.0	.9	2.13	1.25	65.78	1.072	1.40	13.34	3.03	Do.
19	17	3102	1	11.0	1.0	2.29	1.43	61.08	1.074	1.16	13.46	4.46	Do.
20	17	3129	1	9.8	.9	1.43	.88	45.02	1.076	.71	11.90	5.89	
22	17	3164	1	8.6	.8	1.40	1.00	56.61	1.078	1.33	13.72	4.47	Dirty green.
25	17	3219	1	9.4	.8	1.28	1.19	60.55	1.078	1.44	14.25	1.75	Light green.
27	17	3275	1	10.0	1.1	2.09	1.54	57.02	1.080	1.77	13.72	4.89	Light brown.

* Topped August 28.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Oct. 29	17	3314	1	8.9	0.8	1.59	1.01	65.65	1.079	2.29	12.68	3.52	Dirty brown.
30	17	3344	1	11.0	1.1	1.97	1.24	58.23	1.075	1.13	13.17	4.82	Do.
Nov. 3	18	3393	1	8.5	1.0	1.28	1.18	63.00	1.069	.97	12.03	3.93	Dark green.
5	18	3429	1	3.9	1.0	1.42	1.00	60.13	1.068	1.54	12.92	2.63	Do.
9	18	3483	1	9.0	1.0	1.82	1.62	70.34	1.066	.75	12.39	3.00	Green.
12	18	3507	1	9.0	.8	1.18	.88	61.75	1.072	2.40	11.35	3.24	Dirty green.
15	18	3537	1	9.5	.9	.71	.65	42.37	1.067	1.02	11.87	3.65	Dark green.
TABLE No. 12.—HYBRID. E. LINK, GREENEVILLE, TENN.													
July 24	1	155	2	7.2	0.9	3.27	2.50	56.60	1.031	2.85	3.17	2.32	L't gr'n, some starch.
24	2	159	2	7.3	.8	3.22	2.40	56.90	1.030	3.06	3.67	2.18	Darker green.
26	3	193	1	7.7	.8	1.58	1.18	59.25	1.041	2.88	5.43	2.06	Dark green.
27	4	232	1	8.0	.9	1.82	1.41	61.54	1.039	2.89	5.60	1.66	Do.
30	4	301	1	8.5	.8	1.35	1.06	65.56	1.050	2.62	6.90	2.91	Do.
30	5	302	1	8.7	.9	1.72	1.41	65.47	1.045	2.76	5.71	2.68	Do.
Aug. 2	5	371	1	9.3	.9	2.01	1.58	69.41	1.050	2.44	7.50	2.82	Light green.
3	6	398	1	8.8	.9	1.71	1.30	65.42	1.057	2.82	9.23	2.14	Light green, starchy.
5	7	488	1	9.0	1.0	1.50	1.18	64.93	1.058	2.43	8.55	3.86	Dark green, starchy.
9	8	590	1	8.2	1.0	1.66	1.29	79.39	1.061	1.68	10.42	3.12	Do.
14	9	808	1	10.2	1.1	2.28	1.71	64.82	1.063	2.23	10.72	2.71	Dark green, watery.
19	9	949	1	8.5	0.9	1.88	1.38	64.14	1.066	1.51	11.86	2.95	Dark green, starchy.
19	9	950	1	9.0	1.0	1.73	1.32	66.33	1.067	1.41	12.22	3.01	Do.
19	10	951	1	8.8	.9	1.83	1.38	63.69	1.076	1.03	14.28	3.28	Do.
19	10	952	1	9.5	.9	1.83	1.45	62.63	1.072	1.29	13.47	3.01	Do.
23	11	1117	1	9.0	1.0	2.26	1.71	61.48	1.074	1.04	13.33	4.21	Do.
23	11	1118	1	9.0	.8	1.60	1.31	65.50	1.065	1.41	11.60	3.14	Do.
26	11	1239	1	9.0	1.0	2.06	1.46	61.54	1.075	1.16	14.08	2.76	Do.
26	11	1240	1	8.5	1.0	1.89	1.40	61.23	1.077	1.06	14.20	3.08	Do.
26	12	1241	1	9.0	1.0	2.04	1.49	63.81	1.077	.85	13.91	3.58	Do.
26	12	1242	1	9.0	1.0	2.13	1.54	65.74	1.073	1.28	13.37	2.36	Do.
30	13	1431	1	8.5	.8	1.59	1.16	65.29	1.070	1.39	12.74	3.39	Do.
30	13	4432	1	9.0	.9	1.94	1.68	54.46	1.080	1.04	15.13	3.78	Do.
Sept. 3	13	1593	1	6.0	.9	1.82	1.49	64.15	1.079	.88	14.75	3.14	Do.
3	13	1594	1	9.1	1.0	2.13	1.58	64.66	1.078	.88	14.17	3.64	Do.
8	14	1802	1	9.3	.9	1.47	1.16	52.27	1.077	.82	14.28	3.38	D'k g'n, some starch.
8	14	1803	1	9.3	.9	1.92	.96	77.75	1.078	.88	13.99	5.26?	Do.
15	15	2009	1	8.6	.9	1.89	1.28	60.67	1.080	.84	14.92	3.68	Dark green, starchy.
15	15	2010	1	9.0	1.0	1.97	1.34	62.35	1.080	.59	15.49	3.09	Do.
23	16	2306	1	9.5	1.0	2.25	1.38	60.51	1.076	.78	14.82	2.90	D'k g'n, some starch.
23	16	2307	1	9.2	1.1	2.02	1.45	60.61	1.082	.67	16.09	3.33	Do.
25	16	2502	1	9.0	1.0	2.27	1.48	63.59	1.076	.64	13.76	4.18	Do.
25	16	2503	1	9.9	1.0	2.57	1.77	61.04	1.080	.66	14.81	4.11	Do.
Oct. 6	16	2777	1	9.5	1.0	2.38	1.52	64.20	1.076	.51	14.41	3.43	Dark green, starchy.
8	16	2865	1	8.9	.8	2.06	1.18	59.81	1.082	.50	16.04	3.66	Green.
15	17	3024	1	9.4	1.0	2.15	1.40	61.57	1.088	.36	16.47	5.69	Dark green.
16	18	3061	1	9.4	1.0	2.17	1.36	65.26	1.079	.55	14.88	.14?	Do.
22	17	3181	1	9.3	1.1	2.55	1.64	63.36	1.086	.52	16.68	4.99	Do.
26	17	3245	1	9.4	.9	1.77	1.34	62.34	1.085	.49	14.97	4.81	Do.
Nov. 4	17	3410	1	9.0	1.3	1.95	1.42	62.33	1.084	.46	16.43	2.71	Do.
6	18	3453	1	9.5	1.0	1.91	1.26	63.99	1.079	.45	15.42	3.55	Do.
TABLE No. 13.—SUGAR CANE. JOHN W. BORGER, LOVILIA, IOWA.													
July 20	1	68	2	6.8	0.7	1.63	1.23	68.75	1.032	4.94	1.55	1.65	
20	2	69	2	6.8	.7	2.27	1.69	61.21	1.036	5.61	1.83	1.51	
21	3	86	2	7.6	.8	2.70	2.04	54.10	1.036	5.19	1.80	2.13	
21	4	87	2	7.3	.8	2.74	2.02	59.35	1.042	5.13	3.33	2.60	
22	5	115	2	6.8	.8	2.54	1.86	53.61	1.042	4.69	3.81	1.96	
24	6	156	2	7.1	.8	2.59	1.95	51.56	1.042	5.13	3.85	2.15	Light green, some starch.
27	7	233	1	7.0	.9	1.21	.89	64.29	1.051	4.58	5.65	2.95	Dark green, starchy.
29	8	260	2	7.4	.7	2.24	1.78	67.90	1.056	4.62	6.27	3.03	Dark green.
30	9	303	1	7.3	.7	1.19	.90	65.27	1.062	4.64	7.56	3.10	Do.
31	9	333	1	7.4	.7	1.31	1.02	66.23	1.068	4.07	10.31	2.66	Lighter green, starchy.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Aug. 2	9	372	1	6.8	1.0	1.40	1.12	66.27	1.068	3.50	10.49	3.14	Lighter green.
3	9	399	1	7.1	.8	1.28	1.05	66.32	1.068	3.92	11.32	2.08	Light green, starchy.
5	9	487	1	7.6	1.0	1.31	.99	67.24	1.070	3.48	10.70	3.20	Dark green, starchy.
9	9	591	1	7.0	.7	1.32	.98	65.62	1.073	5.27	10.25	2.92	Do.
14	10	807	1	7.0	.8	1.32	1.02	64.12	1.065	2.65	10.84	2.71	Dark green, watery.
19	10	953	1	7.6	.8	1.41	1.10	60.04	1.077	1.73	14.07	3.19	Dark green, starchy.
19	10	954	1	7.1	.8	1.07	.86	68.63	1.074	1.92	11.35	5.21?	Do.
23	11	1115	1	7.3	.7	1.17	.81	62.53	1.076	1.72	13.88	3.22	Do.
23	11	1116	1	7.3	.8	1.21	.94	64.12	1.078	2.24	14.05	3.14	Do.
25	12	1237	1	6.9	.8	1.14	.79	64.54	1.080	1.76	11.57?	6.48?	Do.
25	12	1238	1	7.1	.9	1.41	1.03	64.26	1.078	1.69	12.60	5.05?	Do.
28	12	1377	1	7.9	.8	1.51	.97	61.04	1.076	1.78	13.76	3.65	Do.
28	12	1378	1	6.9	.7	1.20	.84	59.13	1.078	1.72	14.12	3.78	Do.
Sept. 3	13	1591	1	7.3	.7	1.14	.75	60.52	1.078	1.63	13.89	3.36	Do.
3	13	1592	1	7.4	.8	1.53	1.02	60.00	1.076	1.28	13.82	3.02	Do.
8	14	1800	1	7.1	.8	1.26	.87	65.35	1.074	1.42	13.05	2.88	Dark green, some starch.
8	14	1801	1	7.6	.7	1.39	.91	58.91	1.080	1.28	15.27	2.66	Do.
15	15	2007	1	7.1	.9	1.43	.96	63.24	1.079	1.30	14.95	2.80	Dark green, starchy.
15	15	2008	1	7.1	.7	1.19	.84	61.19	1.077	1.25	14.48	2.92	Do.
23	16	2304	1	7.3	.9	1.45	.96	62.84	1.065	1.71	12.13	2.12	Dark green, some starch.
23	16	2305	1	7.2	.8	1.25	.85	58.18	1.079	1.14	14.75	3.25	Do.
25	16	2500	1	7.3	.9	1.50	.95	60.59	1.070	1.25	12.57	3.08	Do.
25	16	2501	1	7.3	.8	1.39	.81	59.19	1.076	1.25	13.49	3.89	Do.
Oct. 6	16	2776	1	8.0	.8	1.12	.78	66.29	1.069	1.20	12.81	2.75	Dark green, starchy.
8	16	2864	1	7.3	.8	1.30	.83	60.90	1.085	1.03	15.49	4.08	Green.
15	17	3023	1	7.4	.8	1.32	.90	65.36	1.078	1.07	13.31	5.19	Dark green.
16	17	3060	1	7.0	.8	1.33	.63	61.38	1.083	1.18	15.12	4.39	Very dark green.
22	17	3180	2	7.6	.8	2.02	1.52	64.20	1.079	1.22	15.19	3.88	Dark green.
26	17	3244	1	7.9	.8	1.05	.73	60.61	1.083	1.19	17.73?	1.39?	Do.
28	18	3291	1	9.6	.8	1.03	.70	60.28	1.076	1.12	14.01	3.74	Green.
28	18	3292	1	8.0	.8	1.17	.87	63.04	1.080	.95	14.59	3.90	Do.
Nov. 4	18	3411	1	7.5	.9	1.23	.92	58.41	1.078	.93	14.36	3.17	Dark green.
6	18	3452	1	6.9	.9	1.06	.81	66.22	1.075	1.20	14.00	3.08	Do.

TABLE No. 14.—OOMSEEANA SORGHUM. D. W. AIKEN, COKESBURY, S. C.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
July 21	1	160	2	6.9	0.6	2.11	1.49	58.38	1.040	3.16	5.15	2.12	Light green.
24	2	161	2	7.5	.8	2.40	1.85	60.12	1.036	2.96	4.51	2.93?	Do.
27	2	235	2	8.6	.8	3.24	2.52	64.80	1.036	2.50	4.73	2.28	Dark green, starchy.
26	3	196	1	7.6	.9	1.61	1.30	56.33	1.047	2.87	6.86	2.02	Lighter green.
27	4	234	1	8.5	.8	1.63	1.26	58.44	1.049	2.72	6.69	2.98	Dark green, starchy.
29	5	262	1	8.4	.8	1.64	1.27	65.08	1.048	3.10	6.41	2.37	Dark green.
30	5	306	1	8.7	.8	1.72	1.37	64.80	1.050	2.47	7.74	2.03	Do.
31	5	332	1	8.7	.9	1.91	1.54	69.29	1.047	2.54	7.00	2.21	Lighter green.
31	6	336	1	6.6	.7	1.59	1.25	68.60	1.053	2.36	8.47	2.51	Lighter gr'n, starchy.
Aug. 2	6	379	1	8.7	.9	1.63	1.32	63.67	1.062	2.45	10.16	3.02	Lighter green.
5	7	481	1	8.7	.9	1.23	1.01	66.30	1.058	2.17	9.42	2.87	Dark green, starchy.
5	8	482	1	9.0	1.0	1.50	1.16	64.00	1.065	2.17	10.58	3.49	Do.
10	9	601	1	9.5	.8	1.46	1.09	65.35	1.064	1.52	11.58	3.06	Do.
16	9	857	1	9.9	1.0	2.09	1.51	65.67	1.063	1.21	11.39	2.73	Do.
16	9	858	1	9.4	.9	1.49	1.14	65.97	1.066	.98	11.68	3.33	Do.
19	10	979	1	9.0	1.0	1.71	1.29	66.72	1.061	1.52	10.49	3.31	Do.
19	10	980	1	10.0	.9	1.89	1.45	68.94	1.063	1.56	10.43	2.91	Do.
23	10	1107	1	10.0	1.0	1.94	1.41	70.87	1.043	2.40	6.81	2.44	Do.
23	10	1108	1	9.4	.9	1.69	1.25	64.91	1.068	1.36	12.59	3.14	Do.
25	10	1229	1	9.6	.9	1.92	1.45	64.38	1.056	1.82	9.65	2.55	Do.
25	10	1230	1	9.7	.9	1.96	1.42	59.97	1.058	1.59	10.27	2.65	Do.
27	11	1339	1	9.5	1.0	1.51	1.09	60.10	1.057	1.64	9.96	2.42	Do.
27	11	1340	1	9.6	.9	1.51	1.10	65.60	1.070	1.64	12.33	3.73	Do.
30	12	1423	1	9.4	.9	1.42	1.08	55.37	1.061	1.48	11.44	2.44	Do.
30	12	1424	1	8.8	.8	1.18	.83	62.46	1.074	1.43	12.90	4.16	Do.
Sept. 2	12	1583	1	9.3	.6	1.00	.69	63.17	1.064	1.54	10.65	3.46	Dark green, some starch.
2	12	1584	1	9.0	.7	1.30	1.08	64.79	1.068	.95	12.18	3.44	Do.
7	13	1787	1	9.5	.9	1.65	1.23	63.97	1.067	1.08	11.91	2.61	Dark green, starchy.
7	13	1788	1	9.6	.9	1.67	1.16	66.40	1.068	.96	9.65?	5.68?	Do.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter of butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	In.	Lbs.	Lbs.	Pr. ct.		Pr. ct.	Pr. ct.	Pr. ct.	
Sept. 15	14	1999	1	9.5	0.8	1.54	1.19	64.37	1.069	1.25	12.59	2.53	Dark green, starchy.
15	14	2000	1	9.0	1.0	2.00	1.48	65.47	1.078	.98	13.97	3.05	Do.
22	15	2291	1	9.5	.9	1.67	1.29	60.65	1.077	.88	14.88	2.71	Dark green, some starch.
22	15	2292	1	11.0	.8	1.28	.99	56.89	1.080	.79	15.26	3.12	Do.
23	16	2352	1	9.4	1.0	1.85	1.31	63.03	1.077	.74	15.06	2.40	Do.
23	16	2353	1	10.3	.7	1.15	.86	57.40	1.084	.74	15.29	3.80	Do.
25	16	2492	1	8.8	.9	1.38	.97	50.22	1.073	.82	13.41	3.75	Do.
25	16	2493	1	9.5	.9	1.38	1.08	57.75	1.084	.71	15.69	3.99	Do.
27	16	2588	1	9.6	.9	1.58	1.14	57.68	1.075	.73	13.38	4.18	Dark green, starchy.
27	16	2589	1	10.8	.9	1.43	1.10	57.20	1.082	.73	15.42	3.44	Do.
Oct. 5	16	2761	1	9.0	.9	1.91	1.25	64.66	1.076	.39	14.50	3.52	Dark green, some starch.
7	16	2826	1	10.8	.9	1.50	1.11	54.54	1.084	.58	15.45	4.26	Green.
15	17	3019	1	8.9	1.1	1.87	1.27	62.09	1.086	.40	15.81	5.71	Dark green.
16	17	3056	1	9.5	.9	1.15	.91	63.77	1.082	.70	14.92	5.10	Do.
22	17	3176	1	9.4	1.0	1.77	1.36	63.31	1.083	.63	15.19	4.12	Do.
26	17	3240	1	12.6	1.2	3.21	2.41	57.72	1.089	.80	16.25	6.32	Light green.
Nov. 4	18*	3415	1	5.5	.9	.98	.91	52.53	1.079	.78	15.00	2.66	Dark green.
13	18	3518	3	6.5	.6	1.24	1.04	57.29	1.068	1.15	11.52	4.18	Do.

TABLE NO. 15.—NEEAZANA. W. H. LYTLE, YELLOW SPRINGS, OHIO.

July 17	1	32	2	6.1	0.8	2.47	1.83	60.05	1.029	4.95	1.13	1.86	
19	2	45	2	7.3	.9	2.86	2.17	56.23	1.033	5.26	1.81	1.45	
22	3	98	2	7.4	.8	2.71	1.98	64.70	1.032	4.72	7.21	3.79	
24	3	143	2	7.7	.7	2.42	1.96	50.16	1.039	4.89	3.22	2.62	Light green.
22	4	97	2	6.6	.8	2.34	1.67	60.90	1.041	5.10	3.48	1.94	
24	4	142	1	8.0	.9	1.86	1.44	54.92	1.038	4.94	3.26	1.82	Darker green.
23	5	123	1	7.2	.8	1.85	1.31	54.77	1.051	4.91	6.08	1.90	Brownish.
26	6	171	1	7.9	.8	1.78	1.36	55.66	1.054	5.40	6.20	1.97	Lighter gr'n, starchy.
27	7	220	1	7.8	.8	1.86	1.39	60.31	1.048	4.62	5.66	1.98	Dark green, starchy.
29	8	250	1	7.8	.8	1.59	1.19	59.28	1.056	4.25	7.41	2.40	Dark green.
30	8	283	1	7.4	.8	1.54	1.14	63.64	1.051	4.38	5.90	2.42	Do.
31	9	320	1	8.1	.8	1.68	1.30	67.23	1.061	4.47	8.35	2.26	Dark green, starchy.
Aug. 2	9	354	1	7.4	.9	1.65	1.30	67.71	1.054	4.03	7.12	1.85	Light green, starchy.
3	9	388	1	7.3	.9	1.62	1.19	66.42	1.064	4.64	7.59	4.13	Do.
4	10	426	1	8.1	.9	2.00	1.52	66.96	1.059	3.92	9.43	1.52	Do.
6	9	508	1	7.5	1.0	1.60	1.19	64.26	1.059	3.71	8.25	2.73	Dark green, starchy.
9	9	570	1	7.7	.9	1.73	1.26	63.24	1.066	3.55	10.71	2.30	Light green, starchy.
5	9	465	1	7.8	1.1	1.79	1.35	64.71	1.060	3.86	8.65	2.58	Dark green, starchy.
5	9	466	1	8.2	1.0	1.64	1.28	64.95	1.064	3.88	9.32	2.82	Do.
5	9	467	1	7.5	1.0	1.56	1.19	67.78	1.061	3.66	8.80	2.76	Do.
5	9	468	1	7.8	1.1	1.56	1.21	65.57	1.065	3.74	9.55	3.00	Do.
7	9	533	1	8.1	.9	1.73	1.29	66.41	1.062	3.58	9.51	2.40	Do.
7	9	534	1	8.0	.7	1.21	.87	66.08	1.066	3.35	10.40	2.81	Do.
7	9	535	1	7.7	.8	1.36	1.13	60.43	1.058	3.84	8.70	2.16	Do.
7	9	536	1	7.6	.8	1.39	1.02	66.81	1.055	3.67	7.77	2.59	Do.
10	9	618	1	7.5	.9	1.71	1.27	59.59	1.063	3.52	9.84	2.44	Do.
10	9	619	1	7.7	.7	1.42	1.07	66.80	1.064	3.66	10.70	1.76	Do.
10	9	620	1	7.9	.9	1.49	1.10	63.80	1.066	3.34	11.06	1.97	Do.
10	9	621	1	7.8	1.0	1.47	1.10	65.20	1.063	3.61	10.12	1.79	Do.
13	10	724	1	8.0	.8	1.10	.81	61.41	1.066	2.87	11.54	2.15	Do.
13	10	725	1	7.8	.9	1.58	1.18	61.11	1.068	3.17	11.50	2.00	Do.
13	10	726	1	7.8	.9	1.56	1.07	64.04	1.072	4.17	11.05	2.42	Do.
13	10	727	1	8.1	.8	1.48	1.06	64.53	1.072	2.41	12.73	2.59	Do.
16	10	853	1	7.6	.8	1.43	.99	64.44	1.067	2.89	9.90	3.70	Do.
16	10	854	1	7.5	.8	1.58	1.06	66.24	1.066	2.69	10.43	3.06	Do.
16	10	855	1	8.1	.9	1.54	1.14	64.26	1.067	2.82	10.68	3.64	Do.
16	10	856	1	7.9	.6	1.39	1.01	65.11	1.068	2.49	11.08	3.14	Do.
20	11	1025	1	7.6	.7	1.32	.99	68.22	1.061	2.58	(†)	......	Do.
20	11	1026	1	7.7	.9	1.59	1.25	65.32	1.068	2.22	(†)	......	Do.
20	11	1027	1	7.5	.8	1.48	1.10	64.97	1.067	2.62	(†)	......	Do.
20	11	1028	1	7.6	.8	1.61	1.19	63.35	1.071	2.66	(†)	......	Do.
24	12	1167	1	8.0	.8	1.42	1.05	62.26	1.070	3.07	11.95	2.60	Do.
24	12	1168	1	8.1	.8	1.41	1.01	64.96	1.073	2.57	12.61	2.99	Do.
24	12	1169	1	7.6	.8	1.44	.97	65.16	1.074	2.53	13.41	2.50	Do.
24	12	1170	1	7.3	.9	1.60	1.14	64.87	1.063	2.95	10.53	2.37	Do.

* Topped. † Not inverted.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	In.	Lbs.	Lbs.	Pr. ct.		Pr. ct.	Pr. ct.	Pr. ct.	
Aug. 27	13	1299	1	7.5	0.9	1.45	1.03	65.24	1.067	2.66	11.80	2.41	Dark green, starchy.
27	13	1300	1	7.6	.8	1.54	1.05	67.57	1.068	2.54	11.79	2.57	Do.
27	13	1301	1	7.4	.8	1.47	1.25	48.86	1.077	2.34	12.56	4.23	Do.
27	13	1302	1	7.1	.9	1.67	1.02	76.53?	1.070	3.01	11.43	3.08	Do.
Sept. 1	12	1519	1	7.5	.8	1.27	.89	65.44	1.059	2.71	9.69	2.61	Do.
1	12	1520	1	8.1	.8	1.52	.96	60.27	1.069	2.16	12.61	2.96	Do.
1	12	1521	1	7.7	.9	1.30	.98	60.81	1.070	2.45	12.54	2.91	Do.
1	12	1522	1	8.1	.8	1.42	.96	64.38	1.068	2.43	12.07	2.92	Do.
4	13	1668	1	8.5	.8	1.61	1.08	62.04	1.075	2.05	13.61	3.04	Do.
4	13	1669	1	7.4	.9	1.85	1.25	64.43	1.068	2.28	12.53	2.18	Do.
4	13	1670	1	7.5	.9	1.61	1.24	62.49	1.066	2.57	10.12	3.77	Do.
4	13	1071	1	7.4	.8	1.27	.79	58.65	1.075	2.28	13.37	2.81	Do.
4	14	1689	1	7.9	.8	1.48	1.07	54.59	1.073	2.31	(*)	......	Do.
4	14	1690	1	7.8	.7	1.45	.94	69.23	1.073	1.95	(*)	......	Do.
4	14	1691	1	8 0	.9	1.66	1.19	53.63	1.072	2.18	(*)	......	Do.
4	14	1692	1	7.9	.9	1.52	1.08	58.67	1.075	2.10	(*)	......	Do.
4	14	1692	1	7.9	.9	1.52	1.08	58.67	1.075	2.10	(*)	......	Do.
4	14	1692	1	7.9	.9	1.52	1.08	58.67	1.058	2.45	9.73	2.04	D'k gr'n, some starch.
9	14	1868	1	7.6	.8	1.69	1.15	67.81	1.058	2.45	9.73	2.04	D'k gr'n, some starch.
9	14	1869	1	7.3	.7	1.62	1.04	65.54	1.068	2.26	12.38	1.84	Do.
9	14	1870	1	7.6	.7	1.45	.90	62.00	1.070	1.93	12.86	2.56	Do.
9	14	1871	1	7.4	.7	1.61	1.30	62.20	1.066	2.18	11.94	2.16	Do.
16	15	2059	1	7.9	.8	1.90	1.31	62.41	1.073	1.97	13.35	2.50	Dark green, starchy.
16	15	2060	1	7.7	.8	1.83	1.10	63.34	1.072	2.24	12.81	2.63	Do.
16	15	2061	1	7.6	.8	1.39	1.01	62.39	1.075	2.06	13.60	2.43	Do.
16	15	2062	1	9.3	.8	1.98	1.45	63.93	1.070	1.86	12.13	2.97	Do.
20	15	2176	1	7.7	.8	1.40	.96	59.95	1.071	1.93	13.05	2.90	Do.
20	15	2177	1	8.3	.8	1.71	.99	58.44	1.072	1.87	13.51	3.04	Do.
20	15	2178	1	7.3	.9	1.50	1.03	57.39	1.071	1.81	12.47	3.65	Do.
20	15	2179	1	8.0	.8	1.51	1.08	61.34	1.074	2.20	13.55	2.82	Do.
24	16	2407	1	7.5	.8	1.21	.79	59.44	1.081	1.45	14.56	4.17	Do.
24	16	2408	1	7.9	1.0	3.01?	1.20	62.03	1.077	1.92	13.81	3.53	Do.
24	16	2409	1	8.0	1.0	1.60	1.10	59.80	1.075	1.99	13.34	3.42	Do.
24	16	2410	1	7.8	1.0	1.46	.91	60.86	1.076	1.79	13.75	3.94	Do.
27	16	2570	1	7.9	.9	2.01	1.38	59.85	1.073	2.00	13.04	2.76	Do.
27	16	2571	1	7.9	.8	1.58	1.08	60.97	1.073	1.99	13.56	2.73	Do.
27	16	2572	1	8.3	.9	1.45	1.02	62.89	1.071	2.09	12.60	2.96	Do.
27	16	2573	1	7.6	.8	1.20	.87	67.51	1.064	2.17	11.70	2.15	Do.
Oct. 1	16†	2691	1	7.8	1.0	1.62	1.27	61.03	1.077	2.07	13.94	3.22	Dark green.
4	16	2741	1	7.6	.9	1.95	1.22	60.00	1.080	1.44	15.42	3.51	Dark green, starchy.
7	16	2809	1	7.2	.9	1.91	1.38	61.12	1.080	1.85	13.55	3.07	Green.
11	16	2901	1	8.2	.9	1.72	1.12	58.19	1.080	......	......	......	Dark green.
13	16	2971	1	9.0	.9	1.94	1.16	61.10	1.080	1.53	14.21	3.75	Light green.
14	17	2997	1	8.0	.7	1.09	.70	64.22	1.081	1.62	14.78	3.38	Dark green.
15	17	3089	1	7.6	.9	1.78	1.17	61.32	1.081	1.68	15.10	3.62	Do.
19	17	3097	1	6.9	.9	1.28	.83	56.61	1.080	1.74	14.73	5.84	Do.
19	18	3121	1	6.9	1.0	1.68	1.17	63.16	1.074	2.07	12.96	3.83	Dirty green.
21	17	3154	1	7.8	.9	1.42	1.02	60.39	1.078	1.52	13.76	4.85	Dark green.
25	17	3214	1	7.6	.8	1.32	1.01	60.48	1.080	1.65	15.31	3.09	Light green.
27	17	3270	1	8.7	.9	1.52	1.11	61.58	1.083	2.17	12.25	6.65	Dirty green.
29	17	3319	1	7.0	.9	1.37	1.02	49.78	1.078	1.27	13.63	4.39	Do.
30	18	3330	1	7.9	1.0	1.64	1.27	61.22	1.073	1.96	13.31	3.67	Dirty brown.
Nov. 3	18	3388	1	6.6	.8	1.02	.81	64.23	1.075	1.93	13.17	3.31	Olive green.
5	18	3424	1	7.0	.6	1.25	.97	63.86	1.069	2.16	13.08	2.49	Dark green.
9	18	3478	1	7.0	.8	1.41	1.09	64.99	1.072	1.71	13.30	2.93	Brownish green.
12	18	3502	1	8.0	.8	1.08	.90	64.39	1.072	1.89	13.18	2.63	Light green.
15	18	3533	1	7.5	.8	.91	.77	70.11	1.071	1.83	13.05	2.46	Dirty green.

TABLE NO. 16.—GOOSE NECK. P. P. RAMSEY, BELGRADE, MO.

July 17	1	36	1	6.9	0.9	1.51	1.12	60.49	1.025	3.85	1.02	1.73	
19	2	42	2	7.8	.8	2.96	2.36	58.06	1.029	4.31	1.56	1.52	
20	3	55	1	8.5	1.0	1.11	1.42	52.75	1.027	4.47	1.03	1.50	
22	4	91	1	8.5	1.0	2.31	1.72	78.30	1.036	5.07	2.16	1.84	
22	5	92	1	7.6	1.0	2.22	1.60	63.27	1.038	4.61	3.54	6.44?	
24	5	137	1	9.2	1.0	2.34	1.74	40.13	1.038	1.70?	6.10?	2.12?	Light green.
27	5	216	1	9.5	.9	1.90	1.47	66.27	1.034	4.05	2.39	2.36	Dark green.
26	6	168	1	9.4	.9	1.81	1.41	64.86	1.041	4.32	4.16	1.89	Dark green, starchy.
27	7	215	1	9.0	.9	1.68	1.28	55.92	1.044	4.55	4.28	2.47	Dark green.
28	8	243	1	9.4	.8	1.58	1.21	63.90	1.044	4.10	4.83	2.13	Dark green, starchy.

* Not inverted. † Topped August 28.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter of butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
July 30	9	279	1	9.0	0.9	2.00	1.53	65.42	1.047	3.64	5.55	2.61	Dark green, starchy.
31	9	316	1	9.5	1.0	2.35	1.83	66.11	1.053	3.48	8.25	1.47	Light green, starchy.
Aug. 2	9	350	1	9.5	.8	1.70	1.28	63.75	1.060	2.68	9.72	2.03	Do.
3	9	383	1	9.3	1.0	2.00	1.52	66.28	1.058	3.45	8.73	2.47	Do.
4	9	423	1	8.3	.9	1.98	1.40	64.99	1.052	2.67	9.80	2.07	Dark green, starchy.
7	9	529	1	9.3	1.0	1.80	1.34	68.31	1.053	3.00	7.75	2.48	Light green, starchy.
9	9	566	1	9.0	1.1	2.11	1.58	60.14	1.059	2.02	10.28	2.41	Do.
5	9	453	1	9.0	1.1	2.11	1.59	64.96	1.060	3.42	9.07	2.51	Dark green, starchy.
5	9	454	1	9.5	1.1	1.65	1.19	70.17	1.051	3.37	6.74	2.78	Do.
5	9	455	1	9.4	1.1	1.72	1.27	66.96	1.052	3.66	6.41	3.05	Do.
5	9	456	1	9.7	1.0	1.62	1.15	66.38	1.058	3.47	7.57	3.28	Do.
10	9	626	1	9.1	1.0	1.94	1.40	68.19	1.059	3.02	9.91	1.05	Do.
10	9	627	1	10.1	.9	1.70	1.28	74.24	1.056	2.83	9.30	1.55	Do.
10	9	628	1	9.3	.8	1.49	1.05	64.21	1.058	2.82	9.49	1.98	Do.
10	9	629	1	9.0	.9	1.49	1.02	65.80	1.058	2.78	9.38	2.35	Do.
12	9	707	1	9.5	1.0	2.02	1.42	64.96	1.058	2.87	9.17	2.37	Do.
12	9	708	1	8.9	.9	1,52	1.05	70.46	1.055	3.06	8.78	1.81	Do.
12	9	709	1	9.5	1.0	1.81	1.25	65.64	1.059	2.58	9.84	2.36	Do.
12	9	710	1	9.0	.9	1.52	1.05	68.91	1.060	2.82	9.58	2.46	Do.
16	9	837	1	9.5	1.0	2.01	1.40	68.42	1.060	2.25	10.29	2.41	Do.
16	9	838	1	10.0	.8	1.47	1.07	65.27	1.060	2.21	9 96	2.36	Do.
16	9	839	1	8.8	.9	1.48	1.01	64.05	1.061	2.14	10.06	1.88	Do.
16	9	840	1	9.8	.9	1.55	1.14	64.81	1.060	2.70	9.88	2.70	Do.
20	10	1009	1	9.6	1.0	1.90	1.29	66.18	1.062	1.66	10.79	2.85	Do.
20	10	1010	1	10.0	.8	1.22	.90	63.39	1.060	1.71	10.39	2.99	Do.
20	10	1011	1	8.7	1.0	1.85	1.41	70.16	1.055	2.22	8.81	2.95	Do.
20	10	1012	1	9.7	.9	1.43	1.08	59.39	1.064	1.23	11.39	3.40	Do.
24	11	1151	1	9.8	1.0	1.89	1.28	68.49	1.059	2.02	10.42	2.48	Do.
24	11	1152	1	9.9	1.0	1.87	1.32	63.12	1.067	1.59	12.66	2.48	Do.
24	11	1153	1	9.8	.9	1.84	1.26	69.63	1.060	1.91	10.95	2.19	Do.
24	11	1154	1	9.8	1.0	1.89	1.32	62.46	1.061	1.69	11.67	2.14	Do.
26	12	1280	1	10.0	.9	1.52	1.25	60.00	1.062	1.87	10.84	2.50	Do.
26	12	1281	1	8.6	1.0	2.09	1.43	70.69	1.057	2.54	9.36	2.15	Do.
26	12	1282	1	9.3	.9	1.57	1.10	66.87	1.063	1.56	11.03	2.67	Do.
26	12	1283	1	8.5	.9	1.63	1.15	64.48	1.064	1.66	10.68	3.21	Do.
Sept. 1	13	1503	1	8.7	.9	1.86	1.18	66.35	1.062	1.91	10.97	2.85	Do.
1	13	1504	1	9.2	.9	1.88	1.40	63.26	1.061	1.39	11.11	3.66	Do.
1	13	1505	1	9.7	.9	1.93	1.40	67.18	1.060	1.83	11.15	2.49	Do.
1	13	1506	1	9.9	1.0	1.85	1.25	64.26	1.060	1.33	11.12	3.07	Do.
3	14	1636	1	10.0	1.0	1.61	1.18	58.84	1.066	1.31	12.83	2.28	Do.
3	14	1637	1	9.1	1.0	1.89	1.30	70.10	1.063	1.59	11.72	2.36	Do.
3	14	1638	1	10.0	.9	1.32	1.01	62.09	1.068	1.21	12.64	7.40?	Do.
3	14	1639	1	8.4	1.0	1.93	1.29	61.22	Lost	Lost	Lost.	Lost	Do.
9	15	1852	1	9.5	.8	1.62	.95	57.40	1.067	1.00	12 24	3.02	Dark green, some starch.
9	15	1853	1	9.5	.8	1.36	.98	60.36	1.070	1.04	12.49	3.06	Do.
9	15	1854	1	9.4	.8	1.71	1.10	59.80	1.068	1.22	12.43	2.97	Do.
9	15	1855	1	9.0	.9	1.93	1.27	42.60	1.068	1.24	10.56	......	Do.
16	15	2043	1	9.1	.8	1.58	1.03	60.89	1.071	1.23	12.81	3.37	Dark green, starchy.
16	15	2044	1	9.5	.9	1.95	1.41	61.83	1.065	1.76	11.65	2.51	Do.
16	15	2045	1	8.8	.9	2.01	1.57	64.00	1.072	1.32	13.09	3.13	Do.
16	15	2046	1	8.9	.8	2.02	1.16	58.36	1.076	1.19	13.77	3.26	Do.
20	15	2160	1	7.8	.8	1.69	1.15	63.11	1.063	.48	12.93	2.16	Do.
20	15	2161	1	9.2	.9	1.85	1.31	64.08	1.065	1.76	12.29	2.15	Do.
20	15	2162	1	9.5	1.0	1.94	1.40	59.84	1.074	1.02	12.23	5.05?	Do.
20	15	2163	1	8.6	1.0	1.86	1.30	43.72	1.069	1.59	13.15	2.52	Do.
24	16	2301	1	9.6	1.0	2,11	1.59	60.08	1.073	1:14	12.84	4.10	Dark green, some starch.
24	16	2392	1	9.0	.8	1.54	1.05	63.46	1.070	1.48	12.68	3.22	Do.
24	16	2393	1	9.9	.8	1.43	.99	55.83	1.075	1.09	13.39	3.94	Do.
24	16	2394	1	9.6	.8	1.36	.94	54.13	1.071	1.20	12.67	3.73	Do.
27	16	2554	1	9.7	.8	1.64	1.13	58.25	1.077	.87	14.06	3.73	Dark green, starchy.
27	16	2555	1	9.4	.9	1.85	1.22	61.80	1.069	1.80	12.23	3.14	Do.
27	16	2556	1	9.6	.8	1.25	.95	59.06	1.077	1.13	13.73	3.42	Do.
27	16	2557	1	9.3	.8	1.39	1.06	57.05	1.079	.98	13.75	4.27	Do.
30	16*	2687	1	8.5	1.1	2.30	1.96	56.29	1.065	2.21	11.63	2.61	Do.
Ot. 4	16	2737	1	9.6	.9	2.10	1.27	65.69	1.080	.66	15.21	4.08	Light green, starchy.
6	16	2792	1	9.5	1.0	2.63	1.38	66.40	1.073	1.42	12.37	4.16	Dark green, starchy.
11	16	2897	1	9.3	1.0	1.76	1.30	64.75	1.077	......	....	......	Dark green.
13	16	2967	1	7.1	.9	1.93	1.05	57.65	1.082	.84	15.11	3.28	Light green.

* Topped August 28.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	In.	Lbs.	Lbs.	Pr. ct.		Pr. ct.	Pr. ct.	Pr. ct.	
Oct. 14	17*	2993	1	7.0	0.9	1.76	1.14	52.03	1.083	.60	15.20	4.28	Dark green.
15	17	3035	1	10.3	1.1	2.04	1.54	65.33	1.078	1.07	11.05?	7.64?	Do.
17	17*	3091	1	8.9	.9	1.67	1.20	57.72	1.080	.85	15.00	4.25	Do.
19	17	3117	1	9.0	.8	1.76	1.17	53.95	1.083	.69	15.13	4.73	Do.
21	17	3150	1	9.1	.8	1.21	.86	56.89	1.079	.68	14.32	2.75	Light green.
25	18	3210	1	8.2	1.0	1.52	1.30	66.41	1.073	1.91	13.08	3.70	Dirty light green.
27	17*	3266	1	7.4	.8	1.28	.89	58.02	1.084	1.85	13.97	5.16	Do.
28	18	3304	1	7.6	.8	1.52	1.02	59.74	1.075	1.42	12.73	4.89	Do.
30	18	3335	1	9.8	1.0	1.63	1.35	64.66	1.071	1.27	13.45	Lost.	Light green.
Nov 2	18	3380	1	6.3	.9	......	1.00	48.68	1.061	2.77	9.59	2.72	Dark green.
6	18	3448	1	8.7	1.0	1.24	1.09	61.62	1.075	1.24	13.82	3.29	Yellowish green.
8	18	3463	1	6.0	.8	.55	.48	63.47	1.056	3.35	7.70	2.82	Dirty green.
9	18	3474	1	7.0	.9	1.40	1.22	63.29	1.076	1.31	13.56	3.55	Yellowish green.
10	18	3495	1	9.0	1.0	1.78	1.32	66.28	1.069	2.47	11.27	3.77	Olive green.
13	18	3529	1	10.5	1.1	1.96	1.90	65.55	1.072	1.28	12.96	Lost.	Dark green.

TABLE NO. 17.—EARLY ORANGE. I. A. HEDGES, SAINT LOUIS, MO.

July 19	1	43	1	7.5	0.9	1.82	1.31	60.18	1.031	5.09	1.39	1.56	
20	2	54	1	8.3	.8	2.02	1.54	58.57	1.035	4.83	2.98	1.76	
21	3	73	2	7.5	.7	2.78	2.13	50.52	1.040	5.32	3.19	1.59	
21	4	74	1	8.1	1.0	2.37	1.82	51.08	1.038	5.24	3.46	1.57	
23	5	120	1	7.3	1.0	2.38	1.79	54.57	1.044	4.94	4.46	1.81	Darkish green.
26	6	166	1	8.0	.9	2.28	1.77	63.88	1.044	5.24	4.01	1.67	Green, starchy.
27	7	206	1	8.9	.9	2.26	1.69	37.71	1.052	4.69	7.28	1.48	Light green, starchy.
28	8	240	1	8.2	1.0	2.61	1.96	59.69	1.051	4.58	6.10	1.83	Darker green, starchy.
30	9	275	1	8.6	.8	2.10	1.58	64.90	1.060	4.35	7.74	2.77	Light green, starchy.
31	9	310	1	8.7	.9	2.17	1.59	67.31	1.059	4.19	7.96	2.68	Do.
Aug. 2	9	346	1	8.5	1.1	2.34	1.86	65.30	1.056	4.20	7.96	2.04	Do.
3	10	380	1	7.5	1.0	3.04	1.95	65.68	1.065	3.07	9.88	2.63	Do.
4	9	421	1	8.2	.9	2.30	1.68	66.71	1.060	2.78	9.67	2.46	Do.
9	10	562	1	8.6	.8	2.74	1.59	64.13	1.068	2.93	11.67	2.63	Do.
4	9	441	1	8.0	1.1	2.78	2.06	68.12	1.055	4.06	8.01	1.63	Do.
4	9	442	1	8.5	1.0	2.25	1.69	69.79	1.057	3.82	8.86	1.79	Do.
4	9	443	1	8.5	.9	1.94	1.49	68.34	1.060	3.92	8.98	1.96	Do.
4	9	444	1	7.8	1.0	2.42	1.80	68.28	1.059	3.93	8.27	1.87	Do.
7	9	524	1	7.7	.8	2.33	1.69	66.89	1.059	3.99	9.55	1.24	Do.
7	9	525	1	8.8	.9	2.13	1.68	69.03	1.062	3.47	10.40	1.67	Do.
7	9	526	1	8.8	.9	2.06	1.50	69.57	1.058	3.82	8.92	1.86	Do.
7	9	527	1	7.9	.8	1.65	1.18	69.16	1.061	3.53	9.47	2.17	Do.
12	9	691	1	9.1	1.0	2.52	1.79	70.00	1.061	3.36	10.02	1.99	Dark green, starchy.
12	9	692	1	8.4	1.0	2.39	1.21	80.34?	1.066	3.25	10.75	2.51	Do.
12	9	693	1	0.0	.8	1.31	1.02	....	1.063	1.49	11.68	2.49	Do.
12	9	694	1	8.3	1.0	2.03	1.58	40.30	1.067	3.39	10.81	1.39	Do.
16	10	821	1	8.0	.8	1.85	1.33	65.84	1.069	2.73	11.62	2.67	Do.
16	10	822	1	8.0	1.0	2.29	1.63	66.66	1.068	2.83	10.87	3.01	Do.
16	10	823	1	9.0	.8	1.60	1.18	62.45	1.072	2.66	12.37	2.65	Do.
16	10	824	1	8.4	1.0	2.20	1.58	65.69	1.070	2.94	11.41	2.66	Do.
20	10	993	1	8.4	.9	2.24	1.64	64.45	1.066	2.52	11.40	2.82	Do.
20	10	994	1	8.0	.9	1.81	1.29	66.83	1.072	2.54	12.65	3.09	Do.
20	10	995	1	8.0	1.0	2.03	1.61	66.19	1.071	2.46	12.85	2.62	Do.
20	10	996	1	8.2	1.0	2.18	1.64	64.83	1.072	2.47	12.78	2.89	Do.
23	10	1135	1	8.2	.9	2.41	1.60	63.27	1.075	2.57	13.13	3.09	Do.
23	10	1136	1	8.5	1.0	2.22	1.59	64.64	1.074	2.58	13.58	2.56	Do.
23	10	1137	1	8.2	1.0	2.01	1.41	64.53	1.075	2.91	13.19	2.60	Do.
23	10	1138	1	7.7	1.0	2.26	1.62	65.36	1.069	2.69	12.22	3.10	Do.
26	10	1268	1	8.2	.9	2.09	1.28	70.38	1.068	2.00	9.15?	.93?	Do.
26	10	1269	1	7.5	1.0	2.02	1.32	49.17	1.072	2.41	12.05	2.98	Do.
26	10	1270	1	7.9	1.1	2.12	1.58	70.56	1.071	2.45	12.08	2.93	Do.
26	10	1271	1	8.0	1.0	2.42	1.60	65.59	1.073	2.54	12.36	2.81	Do.
Sept. 1	11	1491	1	8.3	.8	1.83	1.20	62.70	1.065	1.89	10.92	3.48	Dark green, some starch.
1	11	1492	1	8.5	.9	2.01	1.32	61.33	1.069	2.08	12.97	2.49	Do.
1	11	1493	1	8.0	1.0	2.25	1.71	68.80	1.055	2.50	9.62	2.10	Do.
1	11	1494	1	7.5	.9	2.18	1.49	61.62	1.066	2.36	11.10	3.42	Do.
3	11	1620	1	8.5	.9	1.93	1.19	60.37	1.062	1.61	13.36	3.30	Do.
3	11	1621	1	8.1	1.0	2.32	1.62	68.16	1.075	2.11	12.65	3.47	Do.
3	11	1622	1	8.2	1.0	2.35	1.54	65.14	1.074	2.26	13.50	2.96	Do.
3	11	1623	1	7.9	.9	1.39	.95	64.06	1.072	1.88	12.62	3.60	Do.

* Topped August 28.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on Juice.
				Ft.	In.	Lbs.	Lbs.	Pr. ct.		Pr. ct.	Pr. ct.	Pr. ct.	
Sept. 8	12	1839	1	8.5	1.0	2.40	1.47	65.81	1.070	1.89	9.23?	6.03?	Dark green, starchy.
8	12	1840	1	8.5	.9	1.78	1.05	62.81	1.072	1.96	10.90?	5.01?	Do.
8	12	1841	1	8.0	1.0	1.73	1.20	Lost.	Lost.	Lost.	Lost.	Lost.	
8	12	1842	1	7.9	1.0	1.67	1.11	65.61	1.075	1.69	10.73?	5.76?	Dark green, starchy.
16	14	2027	1	8.4	.9	2.69	1.60	64.72	1.066	1.95	11.76	2.57	Do.
16	14	2028	1	8.4	.9	2.51	1.57	63.06	1.077	1.74	13.62	3.49	Do.
16	14	2029	1	9.0	.8	1.90	1.42	38.29	1.074	2.13	12.79	3.33	Do.
16	14	2030	1	7.9	.9	2.34	1.60	66.66	1.073	1.81	13.13	3.47	Do.
18	14	2146	1	8.0	1.1	2.30	1.50	57.50	1.074	1.45	13.48	3.65	Do.
18	14	2147	1	9.4	1.2	2.57	1.57	63.91	1.069	1.73	12.09	3.48	Do.
18	14	2148	1	8.3	1.1	2.24	1.43	61.26	1.071	1.93	12.96	3.36	Do.
18	14	2149	1	8.0	.9	1.65	1.17	62.40	1.075	1.70	12.64	4.59	Do.
24	15	2379	1	9.0	.9	2.25	1.31	54.77	1.070	1.36	10.56?	5.36?	Dark brown, starchy.
24	15	2380	1	7.5	1.0	2.33	1.59	64.12	1.074	1.42	14.36	2.56	Dark green, starchy.
24	15	2381	1	8.6	.9	1.58	1.23	58.39	1.076	1.44	13.90	3.90	Dark brown, starchy.
24	15	2382	1	9.2	1.1	2.76	1.49	60.35	1.077	1.82	13.70	3.61	Do.
27	16	2542	1	7.1	1.2	2.68	1.62	63.81	1.068	1.49	12.78	2.63	Do.
27	16	2543	1	7.6	1.3	2.62	1.88	63.27	1.067	2.06	12.29	2.43	Dark green, starchy.
27	16	2544	1	8.4	1.1	2.31	1.41	62.50	1.073	1.57	13.73	2.31	Do.
27	16	2545	1	8.4	1.0	1.87	1.20	60.48	1.075	1.37	13.87	2.95	Do.
30	14*	2684	1	6.0	1.1	1.96	1.81	64.34	1.060	2.09	11.04	2.06	Do.
Oct. 4	16	2733	1	7.2	1.0	2.66	1.60	62.41	1.078	1.10	15.21	3.04	Do.
6	16	2788	1	9.6	.8	1.87	1.05	61.76	1.078	1.14	14.67	3.35	Olive green, starchy.
8	16	2874	1	8.8	1.0	2.00	1.25	61.22	1.077	1.36	14.23	3.45	Green.
13	16	2963	1	7.3	1.0	2.33	1.05	56.81	1.082	1.25	15.28	3.33	Dark green.
14	17	2990	1	8.3	1.2	2.75	2.09	52.84	1.087	.98	15.98	3.74	Do.
15	17	3032	1	9.0	1.0	1.89	1.13	62.14	1.081	1.08	13.04?	6.33?	Do.
17	18	3088	1	8.3	1.0	2.08	1.21	63.04	1.064	1.70	13.45	3.98	Do.
19	17	3114	1	8.1	1.0	1.81	.99	55.56	1.081	1.40	15.04	5.39	Do.
21	17	3147	1	8.3	.8	1.82	1.19	60.74	1.086	1.82	15.81	4.47	Dirty green.
25	18	3207	1	8.4	1.0	2.40	1.63	67.28	1.075	1.19	13.78	3.63	Dirty green, starchy.
27	17	3262	1	8.3	.9	1.67	1.20	62.94	1.081	1.39	15.49	3.37	Brown.
28	17	3300	1	8.0	1.1	2.11	1.43	60.49	1.083	1.13	15.45	4.43	Dirty green.
30	17	3356	1	8.0	1.0	2.01	1.37	59.97	1.080	.98	12.43	Lost.	Green.
Nov. 2	18	3376	1	8.8	.8	......	1.06	61.57	1.072	1.37	13.26	3.18	Dirty olive green.
6	18	3444	1	8.8	.9	1.83	1.29	59.66	1.079	1.37	14.33	3.72	Dark olive.
8	18	3459	1	8.0	.8	1.00	.79	63.33	1.073	1.29	13.09	3.41	Dark green.
9	18	3470	1	9.0	.9	1.83	1.39	60.95	1.075	1.24	13.84	3.18	Olive green.
10	18	3499	1	8.0	1.1	1.78	1.34	69.29	1.071	1.33	11.49	4.94	Dark green.
13	18	3525	1	9.0	1.1	1.45	1.17	66.98	1.072	1.05	13.29	Lost.	Do.
15	18	3542	1	8.5	1.1	2.01	1.55	71.73	1.035	1.53	10.02	5.16?	Do.

TABLE No. 18.—NEEAZANA. BLYMYER & CO., CINCINNATI, OHIO.

July 19	1	44	2	6.3	0.7	2.24	1.67	57.98	1.031	5.18	1.12	1.60	
21	2	78	2	6.7	.7	2.29	1.74	56.89	1.038	5.55	2.04	2.00	
22	3	95	2	6.8	.8	2.84	2.06	62.35	1.031	4.73	2.53	.80	
24	3	140	2	6.7	.7	2.25	1.65	49.79	1.037	5.73	2.55	1.85	Light green, some starch.
22	4	96	2	6.8	.8	2.73	1.97	58.56	1.036	4.97	2.97	1.23	
24	4	141	1	7.4	.8	1.75	1.33	47.93	1.033	4.62	2.10	1.90	Olive green.
26	5	170	1	6.8	.7	1.20	.94	56.49	1.039	4.11	4.01	1.79	Dark green.
27	6	219	1	7.6	.8	1.81	1.39	59.35	1.046	4.63	4.91	2.36	Dark green, starchy.
28	7	246	1	7.7	.8	1.68	1.27	59.32	1.054	4.86	6.53	2.08	Do.
30	8	282	1	8.1	.8	1.77	1.34	65.24	1.056	4.50	6.88	2.73	Do.
Aug. 2	9	353	1	7.6	.8	1.29	.99	65.27	1.062	3.88	9.05	1.90	Light green starchy.
3	9	387	1	8.0	1.0	1.76	1.37	65.96	1.058	3.97	8.10	2.77	Dark green, starchy.
4	9	425	1	7.4	.8	1.70	1.25	67.31	1.057	3.92	8.51	1.80	Do.
7	9	532	1	7.7	.7	1.43	1.08	63.67	1.057	4.14	9.17	1.12	Do.
9	9	569	1	8.6	.8	1.54	1.18	65.05	1.060	4.03	9.50	1.99	Light green, starchy.
5	9	461	1	7.7	1.1	1.65	1.26	68.95	1.057	3.72	9.72	2.22	Dark green starchy.
5	9	462	1	8.7	1.0	1.60	1.23	66.61	1.064	3.78	7.68	4.56	Do.
5	9	463	1	8.0	1.0	1.53	1.21	65.27	1.067	4.03	9.98	2.67	Do.
5	9	464	1	8.7	1.1	1.60	1.20	64.59	1.064	4.02	8.88	1.99	Do.
11	9	646	1	8.2	.9	1.68	1.19	66.05	1.063	4.00	10.05	2.08	Do.
11	9	647	1	7.4	.7	1.46	.99	62.44	1.067	3.37	11.36	2.19	Do.
11	9	648	1	8.1	.8	1.33	.99	61.64	1.071	3.07	12.00	3.04	Do.
11	9	649	1	7.9	.8	1.28	.96	60.88	1.070	3.45	12.36	1.95	Do.

* Topped August 28.

ANALYSES OF JUICE FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Aug. 12	9	719	1	7.8	0.9	1.31	.97	64.12	1.059	3.93	8.58	2.36	Dark green, starchy.
12	9	720	1	7.1	.8	1.13	1.03	70.98	1.070	3.20	11.25	2.59	Do.
12	9	721	1	7.4	.9	1.65	1.25	64.70	1.059	3.69	8.71	2.33	Do.
12	9	722	1	7.5	.8	1.12	.79	64.62	1.062	3.66	9.27	2.51	Do.
16	9	849	1	8.2	1.0	2.29	1.67	68.22	1.062	1.54	10.17	3.36	Do.
16	9	850	1	7.8	.7	1.23	.91	64.61	1.067	3.26	10.30	2.89	Do.
16	9	851	1	8.0	.7	1.24	.92	64.20	1.068	3.15	10.31	2.81	Do.
16	9	852	1	7.5	.7	1.39	1.00	65.86	1.069	3.11	10.89	2.95	Do.
20	10	1021	1	8.0	.8	1.58	1.24	66.26	1.064	2.88	*	......	Do.
20	10	1022	1	7.3	.8	1.34	1.08	65.65	1.067	2.53	11.05	3.43	Do.
20	10	1023	1	7.8	.8	1.52	1.17	64.88	1.068	2.91	*	......	Do.
20	10	1024	1	7.2	.6	1.01	.73	61.56	1.069	2.50	11.38	3.29	Do.
24	10	1163	1	7.1	.8	1.44	.96	60.96	1.075	2.91	12.74	3.09	Do.
24	10	1164	1	7.8	.8	1.37	.91	68.23	1.074	2.46	13.22	2.80	Do.
24	10	1165	1	8.1	.9	1.51	1.13	65.34	1.072	2.45	12.72	2.83	Do.
24	10	1166	1	8.0	.8	1.42	1.00	65.05	1.066	2.67	11.16	2.73	Do.
27	11	1295	1	8.5	1.0	2.43	1.96	68.95	1.062	3.39	10.00	2.34	Do.
27	11	1296	1	7.7	.8	1.57	1.18	60.45	1.073	2.52	12.25	3.36	Do.
27	11	1297	1	7.4	.8	1.57	1.10	63.80	1.075	2.59	12.54	3.47	Do.
27	11	1298	1	7.0	.7	1.25	.84	63.29	1.071	2.59	12.26	2.84	Do.
27	12	1335	1	7.5	.8	1.19	.86	64.19	1.067	2.80	10.86	3.12	Do.
27	12	1336	1	8.0	.9	1.58	1.13	60.92	1.078	1.95	12.70	4.59	Do.
27	12	1337	1	7.5	.9	1.50	1.18	61.75	1.071	2.53	11.82	3.16	Do.
27	12	1338	1	7.5	1.0	1.38	1.07	65.16	1.070	3.22	11.21	2.86	Do.
Sept. 1	12	1515	1	7.4	.8	1.25	.84	61.78	1.068	2.68	11.80	2.92	Dark green, some starch.
1	12	1516	1	7.0	.8	1.38	.98	64.04	1.062	2.60	10.15	3.16	Do.
1	12	1517	1	8.2	.9	1.82	1.24	63.65	1.072	2.27	13.17	2.98	Do.
1	12	1518	1	7.8	1.0	1.72	1.28	61.00	1.070	2.34	13.02	2.63	Do.
4	13	1647	1	8.0	.9	1.69	1.18	60.52	1.068	2.67	11.90	1.52	Dark green, starchy.
4	13	1648	1	7.5	.9	1.58	1.06	62.48	1.070	2.35	12.60	1.43	Do.
4	13	1649	1	7.2	.7	1.17	.74	61.16	1.077	2.14	15.02	1.87	Do.
4	13	1650	1	7.0	.9	1.44	1.06	60.74	1.068	2.58	12.01	2.36	Do.
4	14	1655	1	7.3	.8	1.17	.87	62.94	1.069	1.94	13.13	1.96	Do.
4	14	1656	1	7.5	.8	1.45	.98	63.98	1.072	2.89	12.69	2.05	Do.
4	14	1657	1	7.4	.9	1.20	.89	59.40	1.076	2.04	14.61	2.03	Do.
4	14	1658	1	7.6	1.0	1.41	1.01	60.86	1.079	2.29	14.02	3.20	Do.
9	13	1864	1	8.1	.7	1.25	.73	66.96	1.070	1.82	10.75?	4.78?	Dark green, some starch.
9	13	1865	1	8.0	.8	1.90	1.04	59.66	1.069	2.01	12.97	2.09	Do.
9	13	1866	1	7.5	1.0	1.68	1.14	58.33	1.077	2.19	14.33	1.73	Do.
9	13	1867	1	7.0	.9	1.49	1.04	62.07	1.070	2.28	12.57	2.67	Do.
16	14	2055	1	8.1	.8	1.73	1.21	62.69	1.072	2.39	12.60	2.55	Dark green, starchy.
16	14	2056	1	7.6	.8	1.49	1.10	67.06	1.070	2.39	11.55	3.26	Do.
16	14	2057	1	7.4	.8	1.51	1.12	61.64	1.073	2.07	13.02	2.44	Do.
16	14	2058	1	7.5	.8	1.50	1.08	63.73	1.072	2.23	12.95	2.31	Do.
20	15	2172	1	8.0	.8	1.67	1.20	57.61	1.072	1.87	13.49	3.02	Do.
20	15	2173	1	7.3	.9	1.50	1.02	62.16	1.071	2.24	13.12	2.71	Do.
20	15	2174	1	7.8	.9	1.69	1.30	57.80	1.071	1.86	13.20	2.82	Do.
20	15	2175	1	7.1	.8	1.07	.96	47.81	1.070	2.10	12.34	3.08	Do.
24	16	2403	1	8.5	.8	1.39	.98	59.32	1.073	1.90	11.77	4.46	Do.
24	16	2404	1	7.1	.8	1.32	.83	58.20	1.076	1.61	13.98	5.79?	Do.
24	16	2405	1	7.5	.8	1.52	.98	56.85	1.075	1.69	13.53	3.62	Do.
24	16	2406	1	7.6	.8	1.39	.89	61.49	1.080	1.78	13.41	4.62	Do.
27	16	2566	1	6.8	1.0	1.94	1.38	59.04	1.072	2.54	12.92	2.59	Do.
27	16	2567	1	7.7	.9	1.76	1.23	53.26	1.074	1.79	13.95	2.61	Do.
27	16	2568	1	7.6	.8	1.54	1.00	58.46	1.073	1.69	13.29	3.01	Do.
27	16	2569	1	7.9	.9	1.76	1.06	56.89	1.077	1.72	14.13	3.05	Do.
30	16†	2690	1	5.9	.8	1.32	1.13	61.71	1.079	1.99	14.50	2.94	Do.
Oct. 4	16	2740	1	8.0	.8	1.23	.79	55.55	1.088	1.31	16.27	4.57	Olive, starchy.
7	16	2808	1	7.6	.8	1.26	.95	56.19	1.079	1.60	14.18	3.55	Dirty brown.
11	16	2900	1	9.0	.9	1.62	1.07	60.16	1.082	......	......	......	Dark green.
13	16	2970	1	6.5	.8	1.56	.92	62.44	1.076	1.65	13.18	3.63	Dark olive.
14	17	2996	1	9.0	.8	1.58	.88	57.03	1.084	1.14	15.46	3.93	Dark green.
15	17‡	3038	1	8.3	.9	1.34	.91	57.52	1.083	1.21	13.76	5.58	Do.
17	17	3094	1	7.6	.9	1.43	.94	61.21	1.079	1.75	14.08	4.65	Do.
19	18	3120	1	7.0	1.0	1.63	1.03	72.55	1.068	1.73	11.20	5.80	Dirty green.
21	17	3153	1	7.9	.7	1.17	.78	59.21	1.082	1.48	14.06	6.23	Light green.
25	17	3213	1	7.8	.8	1.27	.97	62.53	1.080	1.71	14.67	4.05	Do.
27	17	3269	1	7.3	.8	1.34	1.04	58.90	1.086	1.89	15.87	3.74	Dark green.
29	18	3318	1	6.6	1.0	1.43	1.10	66.33	1.073	2.30	12.20	3.35	Light green.
30	18	3338	1	8.0	1.0	1.89	1.30	Lost.	1.078	2.23	13.35	4.83	Green.
Nov. 2	18	3383	1	7.3	.8	......	.83	61.83	1.078	1.62	14.30	1.80	Dark green.

* Not inverted. † Topped August 28. ‡ Topped.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Nov. 5	18	3423	1	7.3	0.7	1.45	1.03	59.57	1.076	1.84	14.48	1.43	Dark green.
8	18	3466	1	7.5	.8	1.28	.97	68.55	1.071	1.58	13.16	2.74	Do.
9	18	3477	1	8.0	.8	1.39	1.14	64.88	1.072	1.90	12.95	2.83	Brownish green.
12	18	3501	1	7.0	.8	1.21	.97	63.88	1.070	1.61	12.81	2.38	Light green.
15	18	3532	1	8.0	.8	.91	.77	59.60	1.074	1.72	13.69	2.72	Dark green.

TABLE NO. 19.—NEW VARIETY. E. LINK, GREENEVILLE, TENN.

July 24	1	157	2	6.6	0.8	2.57	1.89	57.78	1.037	3.43	3.95	1.93	Light green.
24	2	158	2	7.5	.8	2.72	2.12	50.12	1.037	3.60	4.08	1.96	Do.
26	3	194	1	8.4	.9	1.57	1.23	57.85	1.040	3.55	4.70	1.89	Dark green.
26	4	195	1	8.5	.9	1.74	1.38	58.80	1.041	3.63	4.88	2.89	Lighter green.
29	4	261	1	8.5	.7	1.35	1.04	65.28	1.048	3.29	6.23	2.65	Dark green.
29	5	263	1	9.0	.9	1.83	1.41	66.53	1.040	2.96	4.59	2.40	Do.
30	5	305	1	8.8	.8	1.48	1.24	58.79	1.047	3.22	6.39	2.19	Do.
31	6	335	1	9.5	.8	1.58	1.24	69.04	1.052	2.80	7.99	4.13	Light green.
Aug. 5	7	483	1	9.2	1.0	1.57	1.28	65.41	1.060	2.49	9.40	3.68	Dark green, starchy.
5	8	484	1	9.0	1.1	1.80	1.46	67.22	1.057	2.72	8.33	3.14	Do.
9	9	593	1	8.5	.8	1.42	1.05	63.31	1.064	2.53	10.27	3.13	Do.
18	9	937	1	9.0	.7	1.16	.86	63.71	1.060	2.02	10.29	2.55	Do.
18	9	938	1	9.0	.8	1.26	.92	65.00	1.061	2.01	9.93	3.05	Do.
23	10	1109	1	9.5	.7	1.30	.95	69.75	1.060	1.12	12.09	2.17	Do.
23	10	1110	1	9.0	1.0	1.72	1.23	67.59	1.061	1.75	11.40	2.31	Do.
25	11	1231	1	9.5	.9	1.81	1.26	77.10	1.058	1.51	10.60	3.59	Do.
25	11	1232	1	9.5	1.0	1.89	1.35	66.67	1.064	1.60	11.82	2.37	Do.
30	12	1425	1	9.3	.9	1.62	1.14	65.69	1.063	1.62	11.31	2.97	Do.
30	12	1426	1	9.4	.8	1.90	1.36	67.96	1.063	1.35	11.45	3.01	Do.
Sept. 2	13	1585	1	9.1	1.0	1.50	1.11	67.06	1.066	1.41	11.56	3.16	Dark green, some starch.
2	13	1586	1	9.1	1.0	1.79	1.31	63.02	1.070	1.29	13.30	2.47	Do.
7	14	1791	1	9.6	1.0	1.64	1.21	67.27	1.070	1.18	10.42?	5.32?	Dark green, starchy.
7	14	1792	1	9.2	1.0	1.74	1.34	66.11	1.073	.96	12.29?	4.22?	Do.
15	15	2001	1	9.4	.8	1.20	.86	60.81	1.079	.83	13.68	4.44	Do.
15	15	2002	1	9.0	.9	1.52	1.13	61.01	1.073	1.05	13.45	2.83	Do.
22	16	2293	1	9.9	1.0	1.51	1.28	64.65	1.058	1.91	10.51	1.85	Dark green, some starch.
22	16	2294	1	9.6	.8	1.14	.83	65.30	1.070	1.03	13.41	2.71	Do.
25	16	2494	1	9.5	1.0	1.83	1.35	58.69	1.079	.79	15.14	4.95?	Do.
25	16	2495	1	9.6	1.0	1.76	1.34	62.82	1.079	.61	14.98	3.73	Do.
Oct. 5	16	2762	1	11.0	.8	1.39	1.03	64.10	1.068	1.11	13.31	3.25	Dark green, starchy.
7	16	2827	1	9.4	.9	1.24	.94	70.82	1.060	1.71	9.13	4.21	Do.
15	17	3020	1	9.6	.9	2.05	1.49	59.26	1.086	.61	15.72	5.40	Light green.
16	17	3057	1	8.7	1.0	2.15	1.36	63.43	1.083	.69	15.02	5.74	Dark green.
22	17	3177	1	9.6	1.0	1.86	1.36	61.77	1.085	.65	16.30	4.22	Do.
26	17	3241	1	9.3	.8	1.38	1.09	61.62	1.088	.52	19.06?	3.01?	Do.
28	18	3286	1	10.1	1.0	1.54	1.21	60.15	1.082	.58	15.69	5.17	Green.
28	17	3287	1	9.9	1.0	1.67	1.32	60.83	1.085	.60	15.47	5.91	Do.
Nov. 4	18	3414	1	9.8	.9	1.39	1.08	59.80	1.082	.99	15.12	3.25	Dark green.
13	18	3519	1	7.5	1.0	1.56	1.38	63.69	1.073	1.50	12.78	4.13	Do.

TABLE NO. 20.—CHINESE. D. SMITH, ARLINGTON, VA.

July 20	1	57	2	6.1	0.8	2.68	2.14	54.99	1.033	4.51	2.15	1.67	
22	2	99	2	5.8	.9	2.94	2.55	57.58	1.036	4.62	1.04	5.64	
24	2	144	2	6.6	.8	3.45	2.55	43.22	1.037	5.79	1.60	2.01	Light green.
23	3	124	1	6.9	.8	1.78	1.28	59.14	1.033	5.04	1.59	1.70	Do.
26	4	172	1	6.7	.8	1.53	1.10	59.78	1.039	5.53	2.29	1.95	Dark green.
27	5	221	1	7.8	.8	1.53	1.14	57.69	1.046	4.64	4.62	2.45	Do.
29	5	251	1	7.1	.9	2.03	1.54	64.19	1.052	2.27	7.53	3.94	Do.
30	6	284	1	7.8	1.0	2.55	1.94	63.95	1.046	4.70	4.58	2.24	Do.
31	7	321	1	8.2	.7	1.30	.97	68.18	1.049	4.52	5.41	2.51	Dark green, starchy.
Aug. 2	8	355	1	7.6	.9	1.98	1.53	66.95	1.053	5.46	5.58	1.69	Light green, starchy.
3	9	389	1	7.5	1.1	2.15	1.60	65.01	1.054	5.57	5.86	2.42	Dark green, starchy.
4	9	427	1	6.9	.7	1.30	.96	70.92	1.047	3.98	6.02	1.80	Light green, starchy.
6	9	505	1	8.2	1.2	1.98	1.53	64.20	1.055	4.73	6.71	2.45	Dark green, starchy.
7	9	537	1	7.5	1.0	2.15	1.58	69.31	1.050	3.87	5.96	2.59	Do.
8	9	571	1	7.6	1.0	2.17	1.28	79.25?	1.060	3.41	9.21	2.61	Light green, starchy.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	In.	Lbs.	Lbs.	Pr. ct.		Pr. ct.	Pr. ct.	Pr. ct.	
Aug. 5	9	477	1	8.0	1.1	1.91	1.49	67.26	1.053	5.34	5.50	2.84	Dark green, starchy.
5	9	478	1	8.0	1.0	1.77	1.36	74.92	1.051	4.13	5.96	2.75	Do.
5	9	479	1	8.5	1.0	1.78	1.49	63.62	1.052	5.63	4.61	2.88	Do.
5	9	480	1	7.4	1.0	1.57	1.16	69.14	1.046	4.67	4.37	2.62	Do.
10	9	622	1	7.4	.9	1.54	1.10	46.57	1.055	4.27	7.71	1.76	Dark green, watery.
10	9	623	1	7.6	1.0	2.09	1.54	69.05	1.054	3.91	7.05	2.46	Dark green, starchy.
10	9	624	1	8.7	1.0	2.27	1.58	68.48	1.058	4.03	8.35	2.08	Dark green, watery.
10	9	625	1	7.1	.8	1.55	1.04	72.29	1.042	4.57	4.35	1.49	Do.
13	9	728	1	8.4	1.1	2.04	1.42	58.27	1.053	4.44	6.95	2.00	Dark green, starchy.
13	9	729	1	9.0	1.0	1.57	1.18	61.75	1.068	3.77	8.07	2.62	Do.
13	9	730	1	7.6	.8	1.66	1.16	69.45	1.055	3.55	7.77	2.42	Do.
13	9	731	1	8.6	.7	1.32	.94	68.70	1.059	3.97	8.23	2.01	Do.
17	9	859	1	10.0	.8	1.47	1.10	60.48	1.061	4.62	7.80	2.42	Do.
17	9	860	1	7.9	.9	1.41	1.00	68.72	1.053	3.38	7.28	2.30	Do.
17	9	861	1	8.0	.9	1.67	1.17	66.79	1.062	3.34	9.15	2.76	Do.
17	9	862	1	7.5	.9	1.38	.98	62.78	1.063	3.12	10.00	2.56	Do.
20	10	1029	1	8.1	.8	1.59	1.13	68.71	1.057	3.15	(*)	......	Do.
20	10	1030	1	8.6	.9	1.96	1.41	68.75	1.056	3.26	(*)	......	Do.
20	10	1031	1	8.0	.9	1.48	1.05	69.33	1.055	3.27	(*)	......	Do.
20	10	1032	1	7.0	.9	1.74	1.22	70.00	1.051	3.67	(*)	......	Do.
24	11	1171	1	7.6	.9	2.13	1.42	67.52	1.062	2.67	10.77	2.05	Do.
24	11	1172	1	9.0	1.0	2.37	1.67	70.61	1.053	3.54	7.80	2.05	Do.
24	11	1173	1	7.6	.9	1.84	1.33	63.97	1.061	2.89	9.88	2.50	Do.
24	11	1174	1	8.1	.8	1.67	1.13	68.62	1.062	3.18	9.64	2.58	Do.
27	12	1303	1	8.9	1.0	2.04	1.32	69.05	1.058	3.98	8.14	2.62	Do.
27	12	1304	1	7.4	1.0	2.13	1.49	67.01	1.048	3.07	7.01	2.04	Do.
27	12	1305	1	7.7	1.1	2.05	1.49	68.63	1.056	2.97	8.22	2.87	Do.
27	12	1306	1	7.1	1.0	1.74	1.17	68.17	1.060	2.98	9.23	2.65	Do.
Sept. 1	13	1523	1	7.5	1.0	2.04	1.43	67.48	1.063	2.53	11.45	2.34	Do.
1	13	1524	1	9.0	.9	1.94	1.24	64.76	1.058	2.87	9.44	2.58	Do.
1	13	1525	1	7.8	1.0	2.31	1.57	69.35	1.056	2.57	9.28	2.50	Do.
1	13	1526	1	7.7	1.0	2.27	1.54	66.00	1.059	3.98	8.04	2.66	Do.
4	14	1672	1	9.1	.8	1.65	1.14	68.72	1.063	2.86	10.46	2.34	Do.
4	14	1673	1	8.1	.9	1.98	1.36	65.00	1.062	3.71	9.65	2.32	Do.
4	14	1674	1	8.4	.8	1.33	.94	66.04	1.066	3.38	12.34	1.03	Do.
4	14	1675	1	7.9	.7	1.43	.99	63.62	1.066	2.46	10.54	3.13	Do.
9	15	1872	1	9.5	.8	1.61	.97	66.52	1.062	2.35	10.87	1.99	Dark green, some starch.
9	15	1873	1	7.8	.8	2.11	1.42	69.74	1.055	2.90	8.16	1.83	Do.
9	15	1874	1	8.0	.8	1.91	1.29	66.15	1.063	2.73	10.70	1.95	Do.
9	15	1875	1	7.5	1.0	2.23	1.61	64.68	1.066	2.26	11.91	2.09	Do.
16	15	2063	1	8.8	.9	2.22	1.41	57.29	1.078	.72	14.18	3.55	Dark green, starchy.
16	15	2064	1	9.2	.9	1.95	1.40	61.16	1.075	2.59	12.72	2.64	Do.
16	15	2065	1	7.8	.7	1.36	.93	59.00	1.079	1.90	13.88	3.54	Do.
16	15	2066	1	7.8	.9	1.96	1.35	61.30	1.078	1.80	14.30	2.40	Do
20	15	2180	1	7.1	.9	1.71	1.12	59.36	1.071	.98	10.80?	5.96?	Do
20	15	2181	1	8.1	.8	1.49	1.12	62.72	1.070	1.97	12.89	2.66	Do.
20	15	2182	1	8.0	.9	1.87	1.23	64.55	1.060	5.24	8.12	1.88	Do
20	15	2183	1	7.6	1.2	2.35	1.63	60.37	1.074	2.20	13.17	3.25	Do.
24	16	2411	1	9.4	.8	1.36	.99	56.85	1.079	1.91	13.37	4.23	Do.
24	16	2412	1	9.0	.8	1.14	.81	58.91	1.077	1.67	13.30	5.41	Do.
24	16	2413	1	7.8	.8	2.03	1.36	60.32	1.074	1.98	12.08	4.14	Do.
24	16	2414	1	7.8	1.0	2.13	1.35	57.76	1.079	1.26	13.66	4.35	Do.
27	16	2574	1	9.3	.9	1.45	1.02	61.09	1.071	2.35	12.04	3.36	Do.
27	16	2575	1	9.5	.9	1.60	1.14	61.43	1.075	2.05	12.86	3.47	Do.
27	16	2576	1	8.0	.8	1.40	.90	61.24	1.075	2.21	12.60	3.95	Do.
27	16	2577	1	7.6	.8	1.35	1.65	64.13	1.076	2.01	12.92	3.81	Do.
Oct. 1	16†	2692	1	6.7	1.0	1.62	1.25	63.86	1.074	1.92	13.08	3.01	Dark green.
4	16	2742	1	7.8	.9	1.23	.79	61.97	1.071	1.93	12.74	3.18	Dark green, starchy.
7	16	2810	1	9.6	.9	1.25	.84	63.42	1.077	1.79	13.32	3.41	Green.
11	16	2902	1	8.0	.9	2.15	1.35	59.93	1.081	......	......	......	Dark green.
13	16	2072	1	6.6	.8	1.90	.97	58.82	1.084	1.52	15.23	3.09	Do.
14	17	2998	1	8.5	.9	1.89	1.41	55.45	1.090	1.11	15.68	4.82	Do.
15	17	3040	1	9.4	.8	1.34	.88	56.28	1.083	1.50	14.06	5.18	Dirty green.
19	17	3098	1	7.6	.9	1.63	.90	58.64	1.082	1.39	14.71	4.34	Dark green.
19	17	3122	1	7.0	1.0	1.74	.97	59.95	1.081	1.38	14.10	4.59	Do.
21	17	3155	1	9.6	.9	1.67	1.14	57.36	1.084	1.15	14.26	6.36	Light green.
25	18	3215	1	7.5	.9	1.62	1.22	59.64	1.078	2.16	13.62	3.14	Dirty green.
27	17	3271	1	8.9	.8	1.12	.87	52.66	1.086	1.44	14.87	5.24	Dark green.
29	18	3320	1	6.9	.9	1.85	1.01	64.99	1.073	2.48	12.03	2.87	Do.
30	18	3340	1	10.0	1.0	1.41	1.03	63.19	1.078	1.45	13.72	4.60	Green.

* Not inverted.

† Topped August 28.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter in butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	In.	Lbs.	Lbs.	Pr. ct.		Pr. ct.	Pr. ct.	Pr. ct.	
Nov. 3	18	3389	1	9.6	0.9	1.11	0.86	63.33	1.078	1.51	13.57	2.38	Dark green.
5	18	3425	1	7.5	.6	.98	.69	52.06	1.071	1.72	13.12	3.23	Very dark green.
9	18	3479	1	7.5	1.0	1.81	1.50	64.13	1.078	1.53	9.62?	6.83?	Dark green.
12	18	3503	1	7.3	.8	1.13	.91	61.11	1.074	1.52	13.01	3.19	Do.
15	18*	3534	1	6.5	.9	1.44	1.33	63.64	1.069	1.37	12.59	2.78	Do.

TABLE NO. 21.—WOLF TAIL. E. LINK, GREENEVILLE, TENN.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter in butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
July 30	1	297	1	7.3	1.0	1.80	1.41	62.50	1.037	2.82	4.19	2.20	Dark green.
30	2	298	1	7.7	1.0	1.90	1.46	63.29	1.035	5.19	1.24	2.46	Do.
Aug. 2	3	366	1	8.0	1.0	1.96	1.49	65.04	1.044	3.96	4.60	2.89	Light green, starchy.
2	4	367	1	8.3	1.0	1.61	1.27	68.78	1.038	2.63	4.90	1.49	Do.
2	5	368	1	7.5	1.0	1.87	1.40	68.98	1.041	2.44	5.58	2.45	Light green.
4	5	437	1	8.8	1.0	2.06	1.52	65.65	1.045	2.33	6.92	1.95	Light green, starchy.
6	6	522	1	7.7	1.0	2.45	1.83	65.66	1.046	2.78	5.99	2.61	Dark green, starchy.
6	7	523	1	7.5	1.1	2.42	1.82	68.24	1.047	2.28	6.79	2.68	Do.
9	8	586	1	8.7	.8	1.80	1.36	59.20	1.056	2.44	9.24	2.67	Do.
19	8	941	1	8.0	.8	1.27	.91	64.49	1.063	2.00	10.68	2.84	Do.
19	8	942	1	7.4	.7	1.10	.79	60.91	1.067	2.48	10.93	3.46	Do.
19	9	943	1	8.3	1.1	2.34	1.66	65.65	1.059	1.83	9.89	2.92	Do.
19	9	944	1	7.1	.9	2.10	1.44	66.16	1.061	1.91	10.27	2.81	Do.
26	10	1245	1	8.7	.9	1.98	1.25	64.54	1.058	1.74	10.95	1.68	Do.
26	10	1246	1	8.5	.9	1.94	1.25	62.86	1.062	1.73	10.60	2.78	Do.
Sept. 1	11	1539	1	8.7	1.0	2.19	1.34	56.23	1.053	1.40	8.72	2.61	Do.
1	11	1540	1	7.3	.9	1.93	1.23	66.79	1.066	1.41	11.10	3.53	Do.
3	11	1597	1	9.1	.9	1.84	1.17	65.41	1.056	1.41	10.01	2.50	Do.
3	11	1598	1	8.0	.9	1.98	1.15	68.51	1.063	1.15	11.33	2.81	Do.
8	12	1811	1	8.0	.7	1.37	.85	64.03	1.056	.95	10.13	.66?	Dark green, some starch.
8	12	1812	1	8.0	.8	1.10	.83	63.20	1.048	1.65	7.32	9.17?	Do.
18	13	2123	1	8.1	.9	1.80	1.25	62.80	1.072	.96	12.30	3.90	Dark green, starchy.
18	13	2124	1	8.0	.9	1.93	1.26	57.74	1.065	1.26	11.62	3.22	Do.
23	14	2310	1	8.6	1.1	1.98	1.44	58.23	1.070	1.00	13.45	1.25	Dark green, some starch.
23	14	2311	1	7.6	.9	1.27	.84	58.31	1.066	1.24	11.63	3.08	Do.
27	15	2519	1	9.0	1.0	2.13	1.49	58.94	1.071	2.76	13.69	.82	Dark green, starchy.
27	15	2520	1	8.0	.9	1.55	1.00	58.26	1.076	.93	14.35	2.61	Do.
Oct. 1	15†	2708	1	7.0	1.0	2.28	1.63	64.19	1.075	1.06	13.85	2.53	Green.
6	15	2779	1	8.7	.9	1.79	1.24	64.95	1.073	.66	12.94	3.87	Dark green, starchy.
8	15	2867	1	7.0	1.2	2.23	1.44	63.26	1.074	.93	12.47	4.61	Green.
15	16	3026	1	8.7	.9	1.65	1.05	61.09	1.078	.72	14.30	5.07	Light green.
16	16	3063	1	8.6	1.0	2.02	1.44	65.50	1.076	.66	14.01	4.38	Dirty green.
22	16	3183	1	7.6	.9	1.56	1.02	61.29	1.076	.58	14.79	3.78	Dark green.
26	16	3247	1	7.9	.9	1.10	.87	61.93	1.075	.87	14.14	2.99	Do.

TABLE NO. 22.—GRAY TOP. H. C. SEALEY, COLUMBIA, TENN.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter in butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
July 20	1	58	2	5.5	0.9	3.41	2.42	51.54	1.030	3.19	2.16	1.79	
23	2	125	2	5.8	.7	2.42	1.69	51.08	1.036	3.53	3.75	1.80	Dark Green.
26	3	173	2	9.9	.9	3.00	2.18	61.42	1.040	3.37	4.80	1.59	Do.
27	4	224	1	7.2	.8	1.73	1.28	57.70	1.041	3.30	4.08	2.95	Do.
29	5	251	1	7.1	.9	2.03	1.54	64.77	1.052	2.27	7.53	3.94	Light green.
30	5	285	1	7.2	1.0	1.82	1.57	56.91	1.049	3.07	6.08	3.03	Lighter green.
31	6	324	1	7.4	.9	1.67	1.24	68.68	1.048	3.30	5.81	2.58	Dark green, starchy.
Aug. 2	7	357	1	7.3	1.0	1.86	1.46	67.02	1.057	2.89	8.72	2.92	Light green, starchy.
3	8	391	1	7.7	1.1	2.05	1.54	68.16	1.051	3.14	7.16	2.64	Dark green.
3	9	392	1	5.7	1.2	2.06	1.45	60.68	1.040	2.36	4.85	......	Do.
4	9	428	1	7.0	.8	1.67	1.21	64.09	1.060	2.51	10.05	2.39	Light green, starchy.
6	9	511	1	7.5	1.3	2.08	1.52	69.57	1.049	2.87	6.51	2.68	Dark green, starchy.
7	9	539	1	7.3	1.1	1.86	1.38	68.32	1.052	2.82	7.70	2.65	Do.
9	9	573	1	8.6	.9	1.40	1.07	64.93	1.059	2.54	9.55	2.64	Do.
5	8	469	1	7.4	1.3	1.96	1.52	68.12	1.044	2.78	5.32	2.96	Dark green, starchy.
5	8	470	1	7.4	1.1	1.50	1.12	69.58	1.046	2.95	5.87	2.60	Do.
5	8	471	1	7.6	1.0	1.67	1.27	69.50	1.053	2.62	6.47	4.11	Do.
5	8	472	1	7.2	1.1	1.65	1.24	69.73	1.049	3.15	7.20	1.66	Do.
10	9	610	1	7.0	1.1	1.66	1.19	67.72	1.051	2.66	7.64	2.21	Dark green, watery.
10	9	611	1	8.3	.8	1.42	1.02	67.81	1.056	2.39	8.98	2.31	Do.

*Topped. †Topped August 28.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	In.	Lbs.	Lbs.	Pr. ct.		Pr. ct.	Pr. ct.	Pr. ct.	
Aug. 10	9	612	1	7.6	1.0	1.64	1.27	68.17	1.056	2.58	8.93	2.41	Dark green, watery.
10	9	613	1	7.4	1.0	1.82	1.28	68.16	1.052	2.90	7.70	2.19	Do.
13	9	736	1	7.1	1.2	2.27	1.61	70.28	1.047	2.48	6.71	2.32	Dark green, starchy.
13	9	737	1	7.5	1.0	1.76	1.25	69.78	1.052	2.57	7.95	2.31	Do.
13	9	738	1	6.9	1.1	2.14	1.50	69.11	1.050	2.50	7.26	2.57	Do.
13	9	739	1	7.2	1.1	1.78	1.25	67.78	1.050	2.92	7.16	2.31	Do.
17	9	867	1	7.6	.9	1.60	1.06	65.27	1.063	1.92	10.48	2.79	Do.
17	9	868	1	7.6	.9	1.49	1.05	66.04	1.063	1.79	10.38	3.02	Do.
17	9	869	1	8.7	1.0	1.70	1.28	65.00	1.065	2.21	9.84	3.58	Do.
17	9	870	1	7.6	.9	1.49	1.06	66.05	1.064	2.28	10.65	2.44	Do.
21	9	1048	1	7.9	1.0	1.93	1.45	69.93	1.060	1.82	10.04	3.19	Do.
21	9	1049	1	7.5	1.0	1.84	1.33	68.70	1.061	1.86	10.14	3.03	Do.
21	9	1050	1	8.0	.9	1.69	1.17	71.20	1.050	2.02	7.85	2.80	Do.
21	9	1051	1	8.5	1.0	1.85	1.36	66.50	1.062	2.15	10.41	2.79	Do.
24	10	1179	1	7.1	1.0	1.80	1.23	69.64	1.052	2.42	7.70	2.57	Do.
24	10	1180	1	7.9	.9	1.63	1.11	69.21	1.048	2.25	7.10	2,58	Do.
24	10	1181	1	6.8	1.0	1.61	1.10	68.50	1.050	2.05	7.44	2.89	Do.
24	10	1182	1	7.0	1.0	1.53	1.00	68.50	1.052	1.84	8.56	2.29	Do.
27	11	1311	1	7.9	1.0	1.67	1.14	69.05	1.065	1.88	10.73	3.12	Do.
27	11	1312	1	7.8	1.0	1.87	1.28	70.87	1.043	1.92	6.49	2.38	Do.
27	11	1313	1	7.5	1.0	1.62	1.12	70.39	1.045	2.40	6.58	2.50	Do.
27	11	1314	1	7.0	1.1	1.85	1.26	69.84	1.047	2.44	7.04	2.32	Do.
Sept. 1	12	1531	1	7.0	1.0	1.76	1.20	56.88	1.051	2.03	8.07	2.45	Dark green, some starch.
1	12	1532	1	7.4	1.0	1.85	1.30	62.61	1.053	1.86	8.33	2.93	Do.
1	12	1533	1	7.2	1.2	2.33	1.59	76.07	1.039	2.38	5.07	2.03	Do.
1	12	1534	1	7.3	1.0	1.71	1.05	53.93	1.050	2.40	7.39	2.35	Do.
4	13	1680	1	7.0	1.0	1.63	1.11	60.84	1.050	2.45	7.80	2.04	Dark green, starchy.
4	13	1681	1	8.0	1.1	1.83	1.27	70.26	1.048	2.22	7.34	2.46	Do.
4	13	1682	1	7.5	1.0	1.47	.97	61.31	1.067	1.50	11.93	3.35	Do.
4	13	1683	1	7.0	1.0	1.47	.98	45.39	1.054	2.40	8.40	2.58	Do.
9	14	1880	1	7.0	1.2	2.18	1.45	69.60	1.061	1.53	10.59	2.34	Dark green, some starch.
9	14	1881	1	7.5	1.1	2.10	1.41	69.17	1.058	1.51	9.79	2.73	Do.
9	14	1882	1	7.6	1.2	2.31	1.42	65.74	1.047	2.36	6.94	1.97	Do.
9	14	1883	1	8.0	1.3	3.35	2.26	69.26	1.063	1.40	11.11	2.78	Do.
17	15	2074	1	7.0	1.0	1.73	1.17	64.23	1.078	1.15	13.56	4.82	Dark green, starchy.
17	15	2075	1	7.5	1.2	2.20	1.56	70.94	1.050	2.62	7.33	2.63	Do.
17	15	2076	1	9.8	1.0	1.80	1.34	62.66	1.075	1.19	14.55	2.63	Do.
17	15	2077	1	7.0	1.0	1.79	1.31	64.89	1.065	2.26	11.12	2.62	Do.
20	16	2188	1	7.8	1.2	2.15	1.56	60.70	1.066	1.52	12.14	2.33	Do.
20	16	2189	1	7.4	1.2	2.00	1.44	66.94	1.064	1.64	11.38	2.53	Do.
20	16	2190	1	7.0	1.0	1.42	1.01	64.41	1.064	1.96	11.06	2.72	Do.
20	16	2191	1	8.7	1.0	1.46	1.05	58.40	1.077	1.38	14.37	3.42	Do.
24	16	2419	1	8.1	.9	1.36	.54	58.09	1.081	1.04	14.46	3.97	Do.
24	16	2420	1	7.8	1.0	1.64	.73	60.21	1.078	.91	13.75	4.21	Do.
24	16	2421	1	7.7	1.0	1.74	.77	61.71	1.073	1.34	12.34	4.03	Do.
24	16	2422	1	7.3	.9	1.56	.73	66.67	1.057	2.40	8.72	2.93	Do.
27	16	2582	1	7.9	1.0	1.83	.72	60.74	1.075	1.14	13.43	3.62	Do.
27	16	2583	1	7.2	1.0	1.72	.74	64.29	1.072	1.59	11.72	4.02	Do.
27	16	2584	1	9.7	1.1	2.16	1.06	61.60	1.077	.81	13.91	4.08	Do.
27	16	2585	1	7.6	1.2	1.96	.75	56.81	1.083	1.11	15.02	3.96	Do.
Oct. 1	16*	2694	1	6.5	1.2	1.70	1.32	66.50	1.073	1.40	12.95	3.36	Dark green.
4	16	2744	1	7.4	1.1	1.93	1.35	57.51	1.086	.78	16.29	3.88	Dark green, starchy.
7	16	2812	1	9.8	1.0	1.61	.98	61.34	1.078	1.18	13.81	3.98	
11	16	2904	1	7.8	.9	1.80	1.31	66.22	1.079	......	......	......	Dark green.
13	16	2974	1	7.8	.8	1.52	1.01	62.17	1.088	1.06	14.06	5.46	Do.
14	17	3000	1	7.4	1.0	1.78	1.20	60.90	1.088	.95	15.60	4.22	Do.
16	17	3043	1	7.3	1.1	1.57	1.17	60.11	1.078	1.46	13.87	......	Do.
19	17	3100	1	6.9	.8	1.35	.95	61.16	1.082	1.40	14.71	4.66	Do.
20	17	3127	1	7.4	1.0	1.46	1.07	52.47	1.086	.98	15.96	4.92	
22	17	3162	1	7.8	.8	1.18	.79	50.97	1.090	1.32	15.80	5.13	Dark green.
25	17	3217	1	8.7	.9	1.43	1.21	62.89	1.081	1.21	14.39	3.79	Green.
27	17	3273	1	7.5	1.1	1.45	1.10	62.59	1.080	1.79	14.70	3.04	Dark green.
29	18	3312	1	8.2	.9	1.19	1.00	64.98	1.073	1.92	12.50	3.29	Light brown.
30	18	3342	1	8.5	.9	1.07	.99	60.15	1.072	1.40	12.41	......	Light green.
Nov. 3	18	3391	1	8.1	.9	1.03	.88	63.25	1.074	1.27	12.55	4.24	Dark green.
5	18	3427	1	7.2	1.0	1.08	.88	64.75	1.069	1.60	12.83	2.03	Do.
9	18	3481	1	8.0	.9	1.02	.90	67.48	1.071	.97	10.61?	5.57?	Do.
12	18	3505	1	6.8	1.1	1.46	1.27	68.69	1.069	1.50	12.06	2.72	Do.
15	18†	3535	1	6.0	.9	1.21	1.07	63.65	1.068	1.36	12.03	2.93	Light brown.

* Topped August 1.　　　† Topped.

ANALYSES OF JUICES FROM SORGHUM—Continued.

TABLE NO. 23.—LIBERIAN. BLYMYER & CO., CINCINNATI, OHIO.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	In.	Lbs.	Lbs.	Pr. ct.		Pr. ct.	Pr. ct.	Pr. ct.	
July 27	1	208	1	7.3	1.1	2.95	2.26	61.96	1.037	4.67	2.49	2.34	Dark green, some starch.
28	1	242	1	8.0	1.0	2.32	1.76	61.88	1.039	4.60	3.56	1.46	Dark green, starchy.
31	1	312	1	7.5	.9	1.63	1.25	65.43	1.040	3.38	3.73	3.20	Do.
27	2	209	1	8.3	1.0	2.77	2.14	61.22	1.034	4.91	2.06	1.64	Do.
31	2	313	1	8.8	1.0	2.15	1.68	69.03	1.037	4.74	3.05	1.47	Do.
27	3	210	1	7.8	.8	2.09	1.58	62.99	1.035	4.73	1.99	2.56	Do.
31	3	314	1	8.5	1.0	2.70	2.13	69.25	1.042	5.20	3.86	1.54	Do.
27	4	211	1	8.4	1.0	2.44	1.94	73.88	1.034	4.84	1.61	2.40	Do.
31	4	315	1	8.3	.9	2.28	1.76	68.70	1.041	4.84	3.73	1.71	Do.
30	5	277	1	8.2	.9	2.23	1.69	63.93	1.045	4.04	5.02	2.28	Do.
Aug. 2	5	348	1	8.3	.9	2.37	1.90	67.67	1.049	4.38	5.74	2.42	Light green, starchy.
3	6	381	1	8.0	1.3	2.48	1.93	66.63	1.058	4.39	5.85	2.43	Do.
6	7	505	1	8.8	1.2	2.90	2.33	67.67	1.049	4.19	5.94	2.07	Dark green, starchy.
9	8	564	1	9.7	1.0	2.10	1.68	65.92	1.053	4.27	6.88	2.43	Light green, starchy.
11	8	634	1	8.5	.9	2.46	1.87	48.00	1.061	4.23	8.94	2.38	Dark green, starchy.
11	8	635	1	7.6	1.2	2.45	1.60	66.39	1.059	3.99	9.07	1.86	Do.
11	8	636	1	8.4	1.3	3.39	2.55	65.80	1.054	4.61	7.17	1.83	Do.
11	8	637	1	7.4	1.0	2.37	1.76	64.63	1.058	4.38	8.26	1.87	Do.
12	8	699	1	10.0	1.0	2.37	1.82	78.52	1.058	3.74	7.68	2.99	Do.
12	8	700	1	8.7	.9	2.37	1.80	67.46	1.059	4.16	7.65	2.68	Do.
12	8	701	1	8.5	1.0	2.31	1.71	68.61	1.058	4.37	7.89	2.35	Do.
12	8	702	1	8.2	1.0	2.31	1.79	66.33	1.050	4.61	5.68	2.19	Do.
16	9	829	1	7.7	.9	2.11	1.49	69.70	1.058	3.17	8.84	2.40	Do.
16	9	830	1	7.9	.9	2.33	1.71	68.90	1.060	3.48	8.60	2.59	Do.
16	9	831	1	9.2	1.1	2.58	1.91	69.41	1.051	4.11	6.47	2.03	Do.
16	9	832	1	8.5	.9	2.12	1.56	63.75	1.065	3.43	9.42	3.07	Do.
20	10	1001	1	8.5	1.1	2.56	2.03	66.78	1.061	2.96	9.88	2.81	Do.
20	10	1002	1	8.9	1.0	2.94	2.26	69.00	1.055	3.44	8.08	2.98	Do.
20	9	1003	1	8.1	.9	2.18	1.60	66.39	1.062	3.24	9.85	2.59	Do.
20	9	1004	1	10.0	1.1	3.20	2.35	65.57	1.061	3.48	9.31	3.14	Do.
24	10	1143	1	8.2	1.0	2.70	2.05	66.83	1.060	3.36	9.75	2.69	Do.
24	10	1144	1	8.6	.9	2.37	1.76	85.96?	1.059	3.40	9.08	2.58	Do.
24	10	1145	1	8.6	1.1	2.98	2.22	52.23	1.057	3.41	8.90	2.21	Do.
24	10	1146	1	8.4	1.0	2.76	2.01	64.58	1.062	3.55	9.15	2.84	Do.
26	11	1272	1	8.3	1.2	2.68	2.08	68.15	1.060	3.03	9.16	2.72	Do.
26	11	1273	1	8.7	1.1	3.15	2.22	69.36	1.062	3.14	9.58	2.32	Do.
26	11	1274	1	8.6	1.1	2.63	1.97	68.68	1.060	2.97	9.48	2.31	Do.
26	11	1275	1	8.2	1.0	2.34	1.62	64.76	1.066	3.32	10.08	2.83	Do.
Sept. 1	11	1495	1	9.0	1.0	2.93	2.09	67.51	1.060	3.11	9.37	2.85	Dark green, some starch.
1	11	1496	1	8.9	1.1	2.82	2.07	65.74	1.063	2.93	10.46	2.60	Do.
1	11	1497	1	8.3	1.0	2.22	1.62	68.57	1.055	2.05	8.61	2.61	Do.
1	11	1498	1	8.1	1.0	2.73	1.89	64.76	1.061	3.13	9.33	3.14	Do.
3	12	1628	1	8.4	1.0	1.96	1.30	65.19	1.066	2.32	11.61	2.63	Dark green, starchy.
3	12	1629	1	9.3	1.0	2.65	1.86	62.92	1.064	3.27	10.45	2.10	Do.
3	12	1630	1	8.0	1.0	2.30	1.70	70.98	1.057	2.58	9.97	2.31	Do.
3	12	1631	1	8.6	1.1	3.14	2.34	65.63	1.064	2.78	10.79	2.69	Do.
8	13	1843	1	8.5	1.0	2.53	1.96	62.02	1.074	2.15	13.51	2.04	Do.
8	13	1844	1	9.3	1.0	2.35	1.69	68.31	1.066	2.84	9.31?	4.12?	Do.
8	13	1845	1	7.8	1.3	3.59	2.68	67.35	1.066	2.70	6.86?	6.67?	Do.
8	13	1846	1	9.0	1.1	2.89	2.25	66.40	1.069	2.60	8.44?	5.89?	Do.
16	13	2035	1	8.4	.9	1.78	1.28	62.59	1.070	1.92	12.09	2.90	Do.
16	13	2036	1	9.3	.9	1.89	1.48	50.00	1.074	2.18	12.52	3.55	Do.
16	13	2037	1	8.9	.9	2.57	1.96	63.22	1.073	2.01	12.77	3.02	Do.
16	13	2038	1	7.8	.9	2.50	1.77	62.60	1.075	2.34	12.91	2.89	Do.
20	14	2152	1	8.5	.8	1.66	1.12	60.78	1.069	1.75	12.68	3.11	Do.
20	14	2153	1	8.2	1.0	2.05	1.54	62.75	1.073	1.99	12.67	3.56	Do.
20	14	2154	1	9.1	1.0	2.73	2.12	64.41	1.072	2.16	12.73	2.93	Do.
20	14	2155	1	7.7	1.2	2.99	2.15	61.53	1.076	1.68	14.62	2.66	Do.
24	15	2383	1	8.1	1.1	2.29	2.02	64.08	1.074	1.87	12.75	3.77	Dark green, some starch.
24	15	2384	1	8.6	1.2	3.23	2.21	70.94	1.069	3.39	11.31	2.75	Do.
24	15	2385	1	8.3	1.2	2.93	2.31	62.00	1.078	1.83	14.07	3.49	Do.
24	15	2386	1	8.9	1.1	2.28	1.75	61.38	1.080	1.86	14.18	3.64	Do.
27	16	2546	1	8.6	1.2	2.66	2.31	60.85	1.077	1.50	14.26	.63?	Dark green, starchy.
27	16	2547	1	8.8	1.2	2.55	1.77	62.07	1.075	1.78	12.65	3.38	Do.
27	16	2548	1	9.0	1.1	3.26	2.62	61.17	1.074	2.01	12.50	3.74	Do.
27	16	2549	1	8.9	1.1	2.47	1.98	56.79	1.083	1.26	14.81	3.97	Do.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	In.	Lbs.	Lbs.	Pr. ct.		Pr. ct.	Pr. ct.	Pr. ct.	
Sept. 30	15*	2685	1	7.6	0.7	1.23	1.98	50.66	1.073	2.68	12.37	2.70	Dark green, starchy.
Oct. 4	16	2735	1	9.6	1.0	2.14	1.60	66.85	1.076	1.53	13.64	3.76	Do.
6	16	2790	1	8.9	1.1	2.67	2.11	65.31	1.075	1.88	13.45	3.09	Do.
8	16	2876	1	9.9	1.1	2.79	2.05	59.62	1.080	1.56	14.46	3.01?	Green.
13	16	2965	1	9.0	.9	1.78	1.26	56.00	1.086	1.32	15.03	3.91	Dark green.
14	17*	2991	1	7.5	1.1	2.72	1.46	71.72	1.083	.99	14.52	4.76	Do.
15	17	3033	1	10.0	1.0	2.36	1.61	60.79	1.082	1.68	12.59?	6.17?	Do.
17	17	3089	1	9.0	.9	1.63	1.17	60.90	1.080	1.40	14.66	4.04	Do.
19	17	3115	1	7.9	1.1	3.01	1.87	58.35	1.085	1.41	14.31	4.88	Dark olive.
21	17	3148	1	8.8	1.0	2.71	2.00	59.91	1.079	1.33	14.14	4.82	Dark green.
25	17	3208	1	8.5	1.1	2.42	1.99	53.20	1.078	2.04	13.34	4.01	Dark green, starchy.
27	17	3264	1	10.1	1.3	2.83	2.19	56.88	1.083	1.35	15.06	5.23	Dark green.
28	18	3302	1	7.1	1.0	1.32	1.14	62.31	1.075	3.66	11.46	5.21	Dirty green.
30	18	3333	1	9.0	1.1	2.63	1.90	72.14	1.076	1.51	13.73	3.90	Dark green.
Nov. 2	17	3378	1	9.8	1.0	......	1.82	68.36	1.082	1.59	14.95	3.52	Do.
6	18	3446	1	9.3	1.0	2.08	1.69	62.73	1.080	1.06	14.31	3.70	Do.
8	18	3461	1	8.5	.8	1.49	1.14	64.28	1.073	1.01	13.44	3.20	Dirty green.
9	18	3472	1	9.0	1.0	2.22	1.91	65.05	1.079	1.68	13.92	3.04	Dark green.
10	18	3492	1	9.3	1.0	1.67	1.47	64.37	1.075	1.55	12.78	4.36	Do.
13	18	3527	1	8.0	1.1	2.16	1.82	63.52	1.081	1.33	15.44	Lost.	Very dark green.
15	18	3544	1	10.0	.9	1.70	1.45	64.54	1.073	2.09	12.23	3.64	Do.
16	19	3547	1	9.0	1.1	2.56	2.29	62.42	1.079	1.51	13.49	3.61	Dirty green.
18	19	3552	1	8.8	.9	1.58	1.36	64.62	1.069	2.55	12.17	1.46	Green.
19	19	3555	1	9.5	.9	1.45	1.29	60.31	1.079	1.96	13.81	3.41	
22	19	3557	1	8.6	1.0	1.82	1.65	55.48	1.085	2.13	14.50	1.87	Dark green.
24	19	3559	1	......	......	......	1.56	57.18	1.083	2.55	13.48	3.78	
26	19	3561	1	10.0	.8	1.94	1.61	57.26	1.084	2.38	13.69	3.72	
27	19	3564	1	10.0	1.0	2.06	1.73	50.06	1.083	2.03	14.52	3.44	
29	19	3566	1	6.5	1.0	2.08	1.52	57.45	1.080	2.58	12.55	3.90	
Dec. 1	19	3568	1	8.0	1.0	2.35	1.92	57.60	1.078	3.42	11.64	3.72	
3	19	3570	1	8.0	1.0	2.21	1.92	56.46	1.071	2.93	11.53	4.69	
6	19	3572	1	9.5	1.0	1.52	1.33	54.55	1.071	3.12	9.23	4.71	
8	19	3574	1	8.0	1.0	1.58	1.44	54.66	1.080	5.29	10.30	3.21	
10	19	3576	1	8.5	.8	1.26	1.06	56.25	1.071	5.25	8.09	3.00	
15	19	3578	1	9.5	1.0	1.94	1.62	55.77	1.079	3.68	10.89	3.69	
17	19	3580	1	8.8	1.3	2.06	1.76	43.14	1.084	3.89	11.97	3.51	

TABLE NO. 24.—LIBERIAN. W. H. LYTLE, YELLOW SPRINGS, OHIO.

July 21	1	77	2	6.2	1.0	5.10	3.91	48.28	1.033	4.42	2.33	1.48	
27	2	212	1	7.8	.9	2.13	1.67	63.57	1.036	5.13	1.55	Lost.	Dark green, starchy.
27	3	213	1	8.1	1.0	2.53	1.98	64.75	1.035	5.11	2.01	1.96	Dark green.
27	4	214	1	8.4	.8	1.97	1.51	60.16	1.038	5.06	2.23	2.73	Do.
30	5	278	1	8.0	.8	2.31	1.80	67.32	1.045	4.78	4.32	2.29	Do.
Aug. 2	5	349	1	8.0	1.4	2.76	2.20	66.40	1.048	4.77	5.20	1.48	Light green, starchy.
3	6	382	1	8.3	1.3	2.82	2.19	66.33	1.048	4.65	5.62	2.04	Do.
4	6	422	1	6.3	1.0	3.10	2.23	60.79	1.055	3.95	7.85	1.80	Dark green, starchy.
7	7	528	1	7.8	1.2	3.15	2.42	63.74	1.055	4.27	7.09	2.38	Light green, starchy.
9	8	565	1	9.0	1.1	3.03	2.37	66.11	1.053	4.53	6.75	2.71	Do.
11	8	638	1	8.5	.8	2.04	1.50	62.17	1.054	4.26	7.90	1.83	Dark green, starchy.
11	8	639	1	8.5	1.1	2.62	1.98	45.11	1.056	4.40	7.62	2.18	Do.
11	8	640	1	8.2	1.0	2.82	2.09	66.94	1.054	4.22	7.41	2.03	Do.
11	8	641	1	7.6	.9	2.01	1.49	66.27	1.057	4.60	7.97	1.90	Do.
12	8	703	1	8.6	1.0	2.30	1.74	66.86	1.054	4.25	6.90	2.42	Do.
12	8	704	1	8.1	.8	1.89	1.40	66.77	1.059	4.20	8.01	2.50	Do.
12	8	705	1	8.0	.9	2.11	1.58	68.86	1.057	4.08	7.85	2.31	Do.
12	8	706	1	7.7	1.0	2.21	1.58	70.71	1.060	4.34	8.07	2.55	Do.
16	8	833	1	9.2	1.0	2.17	1.59	65.74	1.060	3.73	8.78	2.49	Do.
16	8	834	1	8.1	1.1	2.28	1.75	68.97	1.055	3.68	7.37	2.46	Do.
16	8	835	1	8.2	1.1	2.58	1.93	66.63	1.056	3.76	7.81	2.45	Do.
16	8	836	1	8.4	1.0	2.36	1.63	67.41	1.057	4.55	7.39	2.25	Do.
20	9	1005	1	8.5	1.0	2.56	1.84	63.97	1.063	3.24	9.97	2.64	Do.
20	9	1006	1	10.2	1.1	2.23	1.72	66.92	1.057	3.68	8.42	2.90	Do.
20	9	1007	1	9.0	1.0	2.27	1.70	68.41	1.059	3.78	8.70	2.44	Do.
20	9	1008	1	8.0	1.0	2.38	1.81	66.14	1.063	3.64	9.58	2.77	Do.
24	10	1147	1	8.1	1.0	2.35	1.62	69.04	1.053	3.94	7.67	2.21	Do.
24	10	1148	1	8.5	1.1	2.85	2.06	68.40	1.060	3.44	9.44	2.21	Do.
24	10	1149	1	9.3	1.2	3.07	2.27	67.88	1.052	3.91	7.48	2.01	Do.

*Topped August 28.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	In.	Lbs.	Lbs.	Pr. ct.		Pr. ct.	Pr. ct.	Pr. ct.	
Aug. 24	10	1150	1	8.6	1.0	3.05	2.20	67.43	1.061	3.44	8.91	3.25	Dark green, starchy.
26	11	1276	1	8.2	1.0	2.34	1.65	69.18	1.064	2.88	9.94	2.92	Do.
26	11	1277	1	9.0	1.2	3.41	2.42	67.27	1.060	3.50	8.77	2.54	Do.
26	11	1278	1	7.7	1.1	2.59	1.96	65.67	1.060	3.43	8.79	2.64	Do.
26	11	1279	1	7.7	1.1	2.66	1.93	64.77	1.064	3.45	9.22	3.07	Do.
Sept. 1	12	1499	1	8.4	.9	2.45	1.60	62.75	1.061	3.26	8.88	3.41	Dark green, some starch.
1	12	1500	1	8.0	1.0	2.74	1.96	67.41	1.061	3.09	9.98	2.48	Do.
1	12	1501	1	9.3	.9	2.41	1.72	67.56	1.059	2.89	9.75	2.33	Do.
1	12	1502	1	9.2	1.1	2.95	2.23	65.81	1.059	3.13	9.81	2.22	Do.
3	13	1632	1	8.5	1.1	2.77	1.94	67.00	1.062	3.04	10.33	2.31	Dark green, starchy.
3	13	1633	1	9.5	1.1	2.20	1.68	62.35	1.069	2.44	12.45	2.14	Do.
3	13	1634	1	8.3	1.1	2.86	2.08	69.17	1.058	3.11	9.60	1.75	Do.
3	13	1635	1	8.4	1.0	1.45	.94	65.73	1.061	3.11	9.85	2.03	Do.
8	14	1847	1	8.0	1.0	2.28	1.70	64.76	1.068	2.20	10.07?	4.59?	Do.
8	14	1848	1	8.0	1.1	2.55	1.86	68.04	1.055	3.02	6.99?	3.83?	Do.
8	14	1849	1	7.8	1.2	2.40	1.83	68.34	1.064	2.41	8.09?	5.24?	Do.
8	14	1850	1	7.6	1.1	2.47	1.76	65.75	1.070	2.48	8.32?	6.49?	Do.
16	15	2039	1	8.6	1.0	2.63	1.90	62.50	1.073	2.50	12.80	2.36	Do.
16	15	2040	1	10.0	.9	2.35	1.78	54.59	1.074	2.09	13.21	......	Do.
16	15	2041	1	7.7	1.0	2.45	1.95	50.28	1.073	2.42	12.86	2.38	Do.
16	15	2042	1	9.3	1.0	1.89	1.60	61.48	1.075	2.14	13.29	2.62	Do.
20	15	2156	1	9.8	1.0	1.87	1.35	61.23	1.069	1.99	12.21	2.91	Do.
20	15	2157	1	8.5	1.1	2.76	2.01	63.15	1.071	2.17	11.75	3.54	Do.
20	15	2158	1	8.4	1.2	2.75	2.02	62.81	1.074	2.49	12.52	2.68	Do.
20	15	2159	1	9.4	1.2	2.40	1.91	60.83	1.073	2.13	11.37	4.72	Do.
24	16	2387	1	9.1	1.2	2.94	2.18	60.68	1.078	1.65	13.96	3.78	Dark green, some starch.
24	16	2388	1	10.3	1.0	2.20	1.67	63.27	1.077	1.51	14.06	3.70	Do.
24	16	2389	1	9.0	1.0	3.06	1.51	60.64	1.077	1.68	13.93	4.35	Do.
24	16	2390	1	8.4	1.2	2.46	1.90	64.03	1.072	3.03	11.20	3.77	Do.
27	16	2550	1	8.0	1.3	3.26	2.35	62.05	1.074	2.15	12.33	3.39	Dark green, starchy.
27	16	2551	1	8.3	.9	1.99	1.41	65.00	1.073	2.25	11.65	3.85	Do.
27	16	2552	1	9.6	1.1	2.40	1.78	61.60	1.075	1.97	13.42	3.04	Do.
27	16	2553	1	7.9	1.1	2.05	1.51	58.28	1.083	1.45	14.64	4.05	Do.
30	16*	2686	1	7.2	1.1	1.65?	2.32	62.62	1.073	3.11	11.92	2.82	Do.
Oct. 4	16	2736	1	8.3	1.0	2.05	1.45	60.35	1.081	1.60	14.43	4.13	Do.
6	16*	2791	1	6.2	1.1	2.28	1.94	66.04	1.068	3.86	9.67	3.19	Do.
8	16	2877	1	9.5	1.1	1.15	1.65	59.49	1.079	1.83	14.44	......	Green.
13	16	2966	1	8.6	.8	1.72	1.08	63.46	1.086	1.32	13.92?	5.30?	Dark green.
14	17*	2992	1	7.7	1.4	3.14	2.51	58.66	1.087	1.10	15.01	5.10	Do.
15	18	3034	1	9.3	1.2	2.52	1.88	63.00	1.077	3.09	11.84	4.54	Do.
17	17	3090	1	10.1	1.1	2.93	2.05	65.67	1.083	1.39	15.24	4.06	Do.
19	17	3116	1	6.6	1.2	2.36	1.66	62.91	1.084	1.64	14.98	4.64	Dark olive.
21	17	3149	1	8.6	1.0	1.97	1.55	64.63	1.080	1.63	13.51	5.65	Dark green.
25	18	3209	1	7.7	1.1	2.62	2.18	64.30	1.078	1.97	13.99	3.57	Dirty green.
27	17	3265	1	9.0	1.1	2.22	1.78	58.52	1.085	1.67	13.95	6.04	Dark green.
28	17	3303	1	8.6	.8	.92	.72	61.49	1.080	1.85	13.69	3.86	Dirty green.
30	18	3334	1	8.9	1.1	2.54	1.75	64.28	1.075	1.83	13.17	5.28	Dark green.
Nov. 2	18	3379	1	9.0	.8	......	.80	49.32	1.075	1.77	13.56	3.27	Do.
6	17	3447	1	7.8	1.1	2.11	1.80	64.63	1.079	1.34	13.98	3.66	Do.
8	17	3462	1	10.0	1.0	2.52	2.11	57.71	1.081	1.10	14.78	3.68	Do.
9	18	3473	1	6.5	1.0	2.19	2.11	64.69	1.078	1.60	13.77	3.30	Do.
10	18	3494	1	7.8	1.1	2.17	1.93	65.18	1.077	2.03	12.49	4.52	Olive green.
13	18	3528	1	8.5	1.0	1.67	1.29	64.28	1.077	1.73	12.91	Lost.	Light green.
15	18	3545	1	9.8	1.0	2.10	1.78	64.32	1.072	2.23	12.24	3.18	Dark green.
16	19	3548	1	7.8	.9	1.54	1.32	55.67	1.078	1.44	14.06	3.38	Dirty green.
18	19	3553	1	8.6	1.1	1.94	1.76	68.00	1.071	3.09	11.61	2.60	Green.
19	19	3556	1	9.5	.9	1.42	1.14	57.56	1.079	1.52	13.99	3.37	
22	19	3558	1	7.3	1.1	1.78	1.71	60.41	1.084	2.59	13.15	3.06	Brownish green.
24	19	3560	1	......	......	......	.91	54.85	1.077	1.95	12.92	4.49	
26	19	3562	1	8.8	.8	1.42	1.23	52.86	1.078	2.75	12.37	3.43	
27	19	3565	1	8.0	1.2	1.70	1.54	51.14	1.086	2.03	14.41	3.82	
29	19	3567	1	7.8	1.0	1.90	1.58	52.02	1.081	3.78	9.96	5.55	
Dec. 1	19	3569	1	8.3	1.1	2.33	2.03	60.85	1.079	3.35	10.93	3.86	
3	19	3571	1	8.5	.8	1.77	1.52	56.89	1.078	3.34	11.64	3.80	
6	19	3573	1	8.5	1.2	2.31	1.99	56.13	1.083	3.86	11.69	4.21	
8	19	3575	1	7.3	1.0	.98	.82	54.30	1.080	4.24	10.05	4.46	
10	19	3577	1	8.5	1.0	1.79	1.52	52.32	1.088	4.14	12.01	Lost.	
15	19	3579	1	8.5	1.0	2.05	1.67	54.44	1.081	4.39	11.25	2.98	
17	19	3581	1	7.8	.8	1.36	1.17	49.53	1.087	5.06	10.49	4.29	

* Topped August 28.

ANALYSES OF JUICES FROM SORGHUM—Continued.

TABLE No. 25.—OOMSEEANA. W. I. MAYES & CO., SWEET WATER, TENN.

Date.	Development.	Number of analysis.	Number of stalk.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	In.	Lbs.	Lbs.	Pr. ct.		Pr. ct.	Pr. ct.	Pr. ct.	
July 27	1	218	1	7.8	0.9	1.63	1.24	62.65	1.032	4.75	1.35	2.67	Dark green, starchy.
28	2	245	1	7.0	1.2	3.35	2.54	56.08	1.038	4.43	3.14	2.01	Very dark green.
30	3	281	1	7.9	.9	2.18	1.71	65.59	1.044	4.86	3.81	2.30	Dark green.
31	3	318	1	8.0	1.0	2.48	1.93	68.64	1.046	5.02	4.24	2.50	Dark green, starchy.
31	4	319	1	8.2	.9	2.08	1.66	67.72	1.048	4.52	4.84	2.76	Do.
Aug. 2	4	352	1	8.7	1.0	2.20	1.75	66.54	1.049	5.30	5.06	1.34	Light green, starchy.
3	4	384	1	9.6	1.1	2.34	1.86	69.36	1.047	4.89	5.20	2.06	Do.
3	5	385	1	8.7	1.1	2.10	1.66	68.21	1.051	5.16	5.83	2.23	Do.
3	6	386	1	8.5	1.1	2.58	2.09	66.07	1.048	4.62	5.59	2.15	Do.
6	6	507	1	8.2	1.2	2.49	1.96	66.63	1.055	4.61	6.72	2.41	Dark green, starchy.
7	7	531	1	8.2	1.0	2.27	1.72	68.33	1.052	4.31	6.55	2.26	Do.
9	7	568	1	9.7	1.0	2.42	1.96	63.60	1.056	4.82	7.14	2.39	Light green, starchy.
11	7	642	1	10.0	1.1	2.53	1.95	67.81	1.054	4.45	7.30	2.05	Dark green, starchy.
11	7	643	1	9.6	1.0	2.52	1.96	65.13	1.056	4.52	7.29	2.39	Do.
11	7	644	1	8.6	.9	2.39	1.78	65.43	1.056	4.92	7.92	1.51	Do.
11	7	645	1	8.9	.8	1.65	1.23	62.07	1.058	4.62	7.91	2.26	Do.
12	8	715	1	8.1	.7	1.36	.96	64.37	1.058	4.09	8.04	2.43	Do.
12	8	716	1	9.5	1.1	2.31	1.76	73.08	1.059	4.38	8.32	2.08	Do.
12	8	717	1	8.5	1.0	2.41	1.89	63.02	1.057	4.27	7.92	1.95	Do.
12	8	718	1	7.6	1.0	1.76	1.38	64.91	1.063	4.29	8.92	2.50	Do.
16	8	845	1	10.0	1.1	2.42	1.73	68.42	1.063	3.70	9.19	2.63	Do.
16	8	846	1	9.8	1.0	2.02	1.61	67.67	1.061	4.28	8.28	2.24	Do.
16	8	847	1	9.4	.8	1.69	1.24	64.53	1.064	4.32	8.92	2.41	Do.
16	8	848	1	8.2	1.0	2.42	1.82	64.48	1.061	4.25	8.16	2.58	Do.
20	9	1017	1	9.4	1.0	2.54	2.03	71.85	1.062	3.83	8.98	2.87	Do.
20	9	1018	1	8.0	1.1	2.18	1.85	66.55	1.064	3.14	10.32	2.75	Do.
20	9	1019	1	9.6	1.0	2.46	2.02	65.50	1.060	3.73	(†)	......	Do.
20	9	1020	1	8.8	.9	2.05	1.57	63.81	1.062	3.57	(†)	......	Do.
24	9	1159	1	10.1	1.0	2.83	2.07	60.49	1.068	3.52	10.83	2.35	Do.
24	9	1160	1	7.6	1.1	2.59	1.90	67.17	1.060	3.22	9.83	2.19	Do.
24	9	1161	1	8.1	1.0	2.74	1.90	69.56	1.058	3.19	9.22	2.33	Do.
24	9	1162	1	8.0	.9	2.25	1.51	68.02	1.056	3.84	8.34	2.02	Do.
27	9	1291	1	9.5	1.1	2.66	2.23	63.73	1.070	3.32	9.86	3.83	Do.
27	9	1292	1	9.6	1.0	2.45	1.77	64.63	1.068	3.56	8.41	4.76	Do.
27	9	1293	1	9.4	.9	1.72	1.25	61.06	1.066	3.52	8.42	4.29	Do.
27	9	1294	1	9.3	1.0	2.49	1.80	63.55	1.068	3.36	8.56	4.65	Do.
Sept. 1	10	1511	1	8.8	.8	1.95	1.30	66.61	1.057	3.37	9.04	2.30	Dark green, some starch.
1	10	1512	1	9.0	1.0	2.51	1.92	63.37	1.061	3.30	10.25	2.24	Do.
1	10	1513	1	7.6	1.0	2.20	1.51	64.96	1.064	2.65	10.82	3.17	Do.
1	10	1514	1	9.0	1.0	2.42	1.72	62.37	1.067	2.94	11.44	3.10	Do.
4	11	1643	1	8.8	.7	1.24	.87	57.72	1.060	2.89	8.98	3.04	Dark green, starchy.
4	11	1644	1	7.7	1.0	2.27	1.69	65.49	1.067	3.44	10.96	2.09	Do.
4	11	1645	1	7.7	1.0	2.49	1.83	64.68	1.070	2.80	11.65	3.03	Do.
4	11	1646	1	9.3	1.0	2.66	1.78	66.00	1.063	3.07	10.02	2.62	Do.
9	12	1860	1	9.0	.8	1.80	1.16	65.59	1.064	2.60	11.40	1.79	Dark green, some starch.
9	12	1861	1	9.4	1.0	2.71	1.81	63.30	1.071	2.23	12.67	2.65	Do.
9	12	1862	1	8.0	1.0	2.78	2.01	67.76	1.065	2.34	11.54	1.94	Do.
9	12	1863	1	8.9	1.1	2.92	2.04	62.63	1.072	1.89	11.56?	5.78?	Do.
16	13	2051	1	8.7	.9	2.38	1.73	64.12	1.078	1.75	14.09	3.22	Dark green, starchy.
16	13	2052	1	9.7	1.1	2.68	2.06	63.42	1.076	1.96	13.37	3.16	Do.
16	13	2053	1	9.4	.8	2.41	1.72	60.07	1.073	2.19	14.01	2.49	Do.
16	13	2054	1	9.2	.9	2.84	2.24	61.29	1.075	2.16	13.13	2.94	Do.
20	14	2168	1	9.2	.9	1.80	1.32	59.86	1.076	1.63	12.95	3.52	Do.
20	14	2169	1	8.0	1.1	2.50	1.82	62.46	1.073	1.83	12.94	3.64	Do.
20	14	2170	1	7.6	1.1	2.79	2.05	64.76	1.072	2.24	12.96	2.71	Do.
20	14	2171	1	7.0	1.1	2.61	1.89	60.58	1.079	1.37	15.10	3.27	Do.
24	15	2399	1	9.8	1.1	2.26	1.76	59.77	1.082	1.44	14.43	4.42	Dark green, some starch.
24	15	2400	1	7.1	1.2	2.64	2.00	63.77	1.074	1.45	13.32	3.71	Do.
24	15	2401	1	9.6	1.2	2.53	1.99	59.60	1.078	1.82	12.32?	5.54?	Dark green, starchy.
24	15	2402	1	7.8	.9	1.38	.98	61.57	1.072	1.46	12.52	4.04	Do.
27	16	2562	1	10.0	1.2	2.86	2.19	55.23	1.080	1.22	15.00	3.59	Do.
27	16	2563	1	8.4	1.2	3.05	2.23	55.72	1.076	1.82	12.86	3.82	Do.
27	16	2564	1	9.6	1.2	3.10	2.18	59.89	1.081	1.35	14.09	4.08	Do.
27	16	2565	1	9.6	1.2	2.82	2.02	58.26	1.080	1.61	13.75	3.85	Do.
30	14*	2689	1	7.6	1.0	2.65	2.09	66.67	1.076	2.39	13.30	2.67	Do.

* Topped August 28.

† Not inverted.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Oct. 4	16	2739	1	8.6	1.1	3.28	2.31	67.09	1.084	1.14	15.61	4.47	Dark green, starchy.
6	16	2794	1	8.4	1.2	2.38	1.84	65.84	1.082	1.61	14.26	4.23	Do.
11	16	2890	1	8.4	.9	1.65	1.06	53.53	1.084	......	......	......	Dark green.
13	16	2969	1	8.9	1.0	2.69	1.81	63.99	1.076	2.22	13.19	2.48	Very dark green.
14	17	2995	1	9.9	1.2	3.19	2.37	58.88	1.086	1.24	15.55	3.97	Dark green.
15	17	3037	1	9.6	1.0	2.30	1.61	62.13	1.081	1.42	13.50	5.20	Do.
17	17	3093	1	8.9	.9	1.54	1.02	58.19	1.088	1.45	15.98	4.31	Do.
19	17	3119	1	8.4	1.2	3.19	2.12	63.11	1.082	1.34	14.42	5.06	Do.
21	17	3152	1	8.7	1.1	2.64	2.00	59.01	1.083	.98	14.31	7.00?	Light green.
25	18	3212	1	9.5	.8	1.47	1.07	61.60	1.077	1.39	14.22	3.38	Green.
27	17	3268	1	8.0	1.1	2.40	1.90	62.20	1.085	1.28	Lost.	Lost.	Dark green.
28	17	3288	1	9.9	.8	1.34	1.03	56.17	1.083	2.14	15.21	2.78	Green.
30	18	3337	1	9.4	1.2	2.46	1.04	Lost.	1.076	1.54	13.27	Lost.	Dark green.
Nov. 2	18	3382	1	7.5	.8	......	1.17	53.21	1.079	1.82	14.80	2.98	Do.
6	18	3450	1	8.4	.9	1.54	1.21	63.27	1.077	1.57	13.62	3.57	Do.
8	18	3465	1	9.3	.8	1.42	1.20	66.24	1.077	1.21	13.96	3.84	Do.
9	18	3476	1	9.5	1.0	2.44	2.00	65.05	1.076	1.38	13.74	3.56	Do.
15	18	3531	1	9.5	.9	1.96	1.53	63.31	1.082	1.51	14.87	3.17	Do.

TABLE NO. 26.—SUMAC. WILLIS POPE, ALABAMA.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
July 27	1	222	2	6.0	1.0	4.59	3.39	41.64	1.041	4.80	2.99	2.58	Very dark green.
27	2	223	2	6.6	1.0	4.46	3.44	58.51	1.041	5.07	3.11	2.39	Do.
31	3	322	1	8.4	1.0	2.14	1.72	66.88	1.047	5.27	4.50	2.22	Dark green, starchy.
31	4	323	1	8.1	.9	1.92	1.49	68.39	1.041	5.12	3.47	1.88	Do.
Aug. 2	4	356	1	8.0	1.0	2.14	1.71	68.55	1.048	5.18	4.73	1.49	Light green, starchy.
3	5	390	1	8.0	1.1	2.81	1.78	67.45	1.052	5.35	6.36	1.79	Dark green, starchy.
6	6	510	1	8.7	1.1	2.05	1.59	66.62	1.054	4.95	6.63	2.08	Do.
7	6	538	1	9.5	1.0	2.33	1.84	67.66	1.056	4.79	7.16	2.16	Do.
9	7	572	1	9.5	1.0	2.30	1.85	66.43	1.053	4.75	6.68	2.29	Do.
11	7	650	1	8.3	1.1	2.56	1.93	66.81	1.055	4.86	7.17	1.67	Do.
11	7	651	1	8.2	1.0	2.25	1.75	66.75	1.054	4.95	7.69	1.02	Do.
11	7	652	1	8.1	1.0	2.09	1.59	65.05	1.059	4.66	7.85	2.32	Dark green, watery.
11	7	653	1	8.0	1.1	2.39	1.79	65.03	1.056	5.15	7.36	1.60	Do.
13	8	732	1	9.0	1.0	2.28	1.70	67.46	1.061	4.28	8.65	2.24	Dark green, starchy.
13	8	733	1	7.5	1.0	2.35	1.75	68.31	1.055	4.50	7.13	2.16	Do.
13	8	734	1	9.0	.8	1.76	1.15	65.42	1.062	4.93	8.83	2.27	Do.
13	8	735	1	8.1	1.1	2.18	1.64	65.10	1.060	4.91	7.83	2.78	Do.
17	8	863	1	9.5	1.0	2.16	1.66	66.16	1.055	4.58	6.90	2.17	Do.
17	8	864	1	9.5	1.0	2.22	1.68	65.58	1.063	3.73	9.33	2.42	Do.
17	8	865	1	8.6	1.0	2.33	1.69	66.71	1.064	3.97	9.37	1.95	Do.
17	8	866	1	7.9	1.0	1.96	1.47	65.59	1.064	4.22	9.20	2.23	Do.
20	9	1033	1	9.9	1.0	2.12	1.66	67.22	1.063	3.74	(*)	......	Do.
20	9	1034	1	8.6	1.1	2.59	2.01	69.89	1.057	3.77	(*)	......	Do.
20	9	1035	1	7.7	1.1	2.22	1.74	68.57	1.061	3.83	(*)	......	Do.
20	9	1036	1	8.4	1.1	1.65	1.87	69.29	1.062	4.51	(*)	......	Do.
24	9	1175	1	9.2	1.0	2.20	1.87	53.18	1.065	3.30	10.55	2.25	Do.
24	9	1176	1	8.4	.9	2.01	1.51	68.51	1.064	3.21	10.23	2.44	Do.
24	9	1177	1	8.0	1.0	2.38	1.76	68.50	1.065	3.83	9.92	2.07	Do.
24	9	1178	1	8.2	1.1	2.44	1.75	64.07	1.061	4.01	8.57	2.74	Do.
27	10	1307	1	9.6	1.0	2.23	1.70	54.46	1.067	3.40	10.68	2.93	Do.
27	10	1308	1	7.6	1.0	2.74	1.97	68.17	1.061	3.56	9.15	2.23	Do.
27	10	1309	1	9.0	1.1	2.37	1.74	69.06	1.068	3.92	8.39	2.67	Do.
27	10	1310	1	7.9	1.0	2.60	1.79	54.55	1.068	3.63	10.65	2.71	Do.
Sept. 1	11	1527	1	9.3	1.0	1.93	1.35	65.84	1.060	3.64	9.44	2.25	Dark green, some starch.
1	11	1528	1	9.3	1.1	2.73	2.05	54.19	1.065	3.03	10.81	2.50	Do.
1	11	1529	1	7.5	1.0	2.03	1.42	66.20	1.062	3.38	9.81	2.88	Do.
1	11	1530	1	8.0	1.0	2.49	1.73	68.66	1.061	3.12	9.19	3.06	Do.
4	12	1676	1	9.1	1.0	1.93	1.35	61.95	1.071	2.51	11.83	3.26	Dark green, starchy.
4	12	1677	1	8.1	1.1	2.96	2.12	63.29	1.052	3.85	7.54	1.68	Do.
4	12	1678	1	9.1	1.0	1.89	1.60	65.70	1.067	3.06	11.10	2.71	Do.
4	12	1679	1	9.0	1.1	2.55	1.80	62.93	1.064	3.31	9.55	3.31	Do.
9	13	1876	1	9.5	1.1	3.69	2.55	64.30	1.069	2.08	12.62	2.56	Dark green, some starch.
9	13	1877	1	9.0	.9	2.16	1.48	68.75	1.061	2.82	10.49	2.05	Do.
9	13	1878	1	9.0	.8	1.73	1.14	69.96	1.046	3.82	6.36	1.48	Do.
9	13	1879	1	8.5	.7	1.17	.74	60.60	1.049	4.46	5.82	1.97	Do.
17	14	2070	1	8.8	1.1	2.55	1.75	57.93	1.080	......	......	......	Dark green, starchy.
17	14	2071	1	9.7	1.0	2.30	1.73	65.01	1.067	3.02	10.80	3.00	Do.

*Not inverted.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Sept. 17	14	2072	1	7.5	1.0	2.51	1.83	65.50	1.071	2.57	11.22	3.86	Dark green, starchy.
17	14	2073	1	8.0	1.0	2.20	1.62	54.60	1.077	2.30	13.63	3.34	Do.
20	14	2184	1	9.0	.9	1.70	1.21	65.86	1.058	3.84	8.97	1.98	Do.
20	14	2185	1	8.5	1.0	2.35	1.74	61.65	1.075	1.91	13.94	3.23	Do.
20	14	2186	1	8.3	1.1	2.02	1.52	57.97	1.075	2.50	13.71	2.54	Do.
20	14	2187	1	7.4	1.0	1.82	1.30	62.54	1.071	2.42	12.56	3.09	Do.
24	15	2415	1	9.8	1.2	2.10	1.56	62.11	1.076	1.89	12.88	4.00	Do.
24	15	2416	1	9.5	1.1	1.74	1.28	61.72	1.076	2.15	12.13	4.17	Do.
24	15	2417	1	9.5	1.0	1.80	1.18	63.55	1.079	1.56	14.03	3.82	Do.
24	15	2418	1	8.2	1.0	2.17	1.57	60.69	1.080	1.55	14.16	3.92	Do.
27	16	2578	1	10.0	1.0	2.28	.84	55.26	1.074	1.98	11.83	4.25	Do.
27	16	2579	1	10.0	1.0	2.20	1.72	57.30	1.080	1.38	13.07	5.12	Do.
27	16	2580	1	7.2	.8	1.41	.92	59.28	1.067	1.73	11.53	3.05	Do.
27	16	2581	1	9.1	1.0	1.98	1.44	57.66	1.072	2.74	11.69	3.38	Do.
Oct. 1	16*	2693	1	7.0	1.3	2.16	1.73	64.70	1.075	2.70	12.70	3.36	Dark green.
4	16	2743	1	9.0	1.1	2.33	1.67	61.57	1.086	1.21	16.48	3.91	Dark green, starchy.
7	16	2811	1	10.4	1.0	2.44	1.74	64.05	1.082	1.62	13.72	3.84	
11	16	2903	1	8.0	1.0	2.42	1.87	62.22	1.083	.....	....	......	Dark green.
13	16	2973	1	8.1	1.2	2.91	2.06	58.17	1.088	1.09	15.55	4.22	Do.
14	17	2999	1	9.6	1.1	2.38	1.71	62.19	1.086	1.63	14.98	3.87	Do.
15	17	3041	1	9.9	1.1	2.12	1.47	62.22	1.086	1.66	13.91?	6.48?	Do.
19	17	3099	1	8.0	1.0	2.31	1.64	58.58	1.088	1.02	15.84	5.07	Do.
20	17	3126	1	9.1	.8	1.78	1.36	57.37	1.082	1.78	14.64	4.68	Do.
21	17	3156	1	9.6	1.1	2.20	1.72	60.10	1.085	1.32	14.56	5.64	Do.
25	17	3216	1	9.0	1.1	2.31	1.89	60.26	1.084	1.35	15.15	4.38	Green.
27	17	3272	1	9.0	1.0	1.87	1.46	61.20	1.084	1.93	15.80	3.20	Dark green.
29	18	3311	1	8.0	1.0	1.83	1.40	60.60	1.081	1.56	11.48	6.33	Do.
30	18	3341	1	9.4	1.0	1.67	1.52	59.71	1.080	1.27	14.38	5.48	Light green.
Nov. 3	18	3390	1	7.5	1.0	2.18	1.83	64.39	1.081	1.17	14.34	4.24	Dark green.
5	18	3426	1	9.5	1.1	1.98	1.61	58.38	1.080	1.70	14.41	3.48	Do.
9	18	3480	1	6.0	1.1	2.05	1.97	55.58	1.061	2.21	12.34	.65?	Dark olive.
12	18	3504	1	7.8	1.0	1.66	1.46	64.50	1.072	1.69	12.13	3.50	Dark green.

TABLE No. 27.—MASTODON. D. W. AIKEN, COKESBURY, S. C.

July 26	1	197	2	8.3	0.8	3.19	2.48	69.56	1.037	2.53	4.19	3.02	Dark green.
26	2	198	1	7.3	.8	1.53	1.13	54.43	1.039	3.49	4.60	2.06	Do.
26	3	199	2	8.2	.8	2.77	2.09	61.81	1.034	4.63	2.72	1.64	Dark green, starchy.
26	4	200	1	9.1	.9	2.05	1.61	62.86	1.035	4.69	2.48	1.77	Do.
Aug. 10	5	600	1	10.0	1.0	1.72	1.40	66.30	1.054	3.29	7.98	1.43	Do.
12	5	723	1	9.5	.9	1.38	1.01	65.76	1.063	2.70	10.41	2.32	Do.
19	4	961	1	13.0	1.1	3.21	2.64	68.45	1.046	2.84	6.72	2.39	Do.
19	4	962	1	12.2	.8	2.04	2.17	70.14	1.044	3.71	5.80	2.08	Do.
19	5	963	1	13.2	1.0	3.05	2.45	67.49	1.048	4.30	7.39	.81	Do.
19	5	964	1	9.4	1.1	2.39	1.85	66.39	1.048	4.74	5.58	2.13	Do.
19	6	965	1	11.6	.9	1.94	1.58	69.82	1.057	2.40	9.43	2.88	Do.
19	6	966	1	11.1	1.1	2.60	2.05	67.31	1.057	2.84	9.08	1.94	Do.
23	6	1105	1	12.7	1.2	2.66	2.12	70.05	1.042	4.61	4.94	1.25	Do.
23	6	1106	1	12.5	1.2	3.04	2.09	79.32?	1.042	4.82	4.70	1.42	Do.
24	7	1187	1	13.0	1.0	2.85	2.27	66.83	1.057	2.32	9.93	2.08	Do.
24	7	1188	1	12.6	1.0	2.44	2.06	68.71	1.057	2.31	9.49	2.39	Do.
28	7	1373	1	13.1	1.1	3.28	2.69	70.17	1.057	5.61	7.15	1.81	Dark green, watery.
28	7	1374	1	12.1	1.0	2.13	1.69	61.79	1.063	1.72	11.33	2.90	Dark green, starchy.
28	8	1375	1	12.6	1.2	3.60	2.88	66.32	1.059	1.53	10.54	2.99	Do.
28	8	1376	1	12.1	.9	2.27	1.73	48.66	1.054	2.80	8.61	2.25	Dark green, watery.
Sept. 2	9	1581	1	12.6	.9	2.15	1.61	64.07	1.060	1.42	10.72	2.86	Dark green, some starch.
2	9	1582	1	12.0	1.1	3.24	2.63	68.84	1.055	3.26	8.49	2.04	Do.
7	10	1785	1	13.8	1.3	4.14	3.30	67.81	1.064	3.51	8.14?	5.03?	Dark green, starchy.
7	10	1786	1	11.0	.9	1.61	1.12	66.80	1.075	2.17	4.56?	1.55?	Do.
7	11	1789	1	12.6	1.1	2.88	2.19	66.24	1.049	1.13	6.37?	4.51?	Do.
7	11	1790	1	11.1	1.1	2.46	1.79	65.11	1.062	1.05	9.40?	4.52?	Do.
14	12	1981	1	10.9	1.3	3.26	2.45	67.36	1.044	1.92	5.97	2.35	Light green, some starch.
14	12	1982	1	9.1	.8	1.20	.88	67.75	1.066	.87	9.98	4.63	Do.
22	13	2289	1	9.5	1.1	2.10	1.59	64.92	1.067	1.02	12.59	2.56	Dark green, some starch.
22	13	2290	1	12.6	1.2	3.83	3.27	63.16	1.068	3.45	11.26	2.05	Do.

* Topped August 28.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Sept. 23	14	2350	1	12.6	1.2	3.41	2.87	68.28	1.056	3.47	8.06	......	Dark green, some starch.
23	14	2351	1	13.5	1.1	2.86	2.42	66.73	1.058	1.12	10.49	2.52	Do.
25	15	2490	1	11.6	.9	2.62	2.29	67.50	1.048	1.34	8.45	2.19	Do.
25	15	2491	1	11.5	.9	1.74	1.37	65.11	1.068	2.69	11.63	2.77	Do.
27	16	2586	1	13.5	1.3	3.89	3.22	61.49	1.070	1.62	13.11	2.61	Dark green, starchy.
27	16	2587	1	14.7	1.2	3.15	2.75	61.36	1.066	1.83	11.52	3.02	Do.
Oct. 5	16	2760	1	11.1	1.1	2.60	2.02	62.75	1.083	.72	16.28	3.13	Do.
7	16	2825	1	9.6	1.0	1.52	1.31	52.68	1.060	4.21?	8.48?	7.12?	Green.
15	16*	3018	1	8.0	1.2	2.60	2.34	67.51	1.070	1.30	13.42	3.41	Light green.
16	17	3055	1	11.0	1.0	1.76	1.41	56.65	1.086	1.04	16.07	5.28	Dark green.
22	17	3175	1	13.1	1.2	3.12	2.67	54.43	1.085	.98	15.92	4.95	Do.
26	17	3239	1	10.4	1.1	2.00	1.80	61.71	1.088	1.95	16.15	3.97	Light green.
Nov. 4	18	3416	1	13.5	1.3	2.68	2.46	65.27	1.076	4.53	11.04	2.68	Dark green.
13	18*	3517	1	6.0	1.2	1.58	1.54	64.62	1.079	1.04	14.31	3.88	Do.

TABLE NO. 28.—IMPHEE. D. W. AIKEN, COKESBURY, S. C.

July 30	1	304	1	7.3	0.9	1.79	1.40	64.21	1.048	6.28	4.08	1.81	Dark green.
31	2	334	1	7.3	1.0	1.44	1.12	64.30	1.052	6.33	4.43	2.60	Dark green, starchy.
Aug. 2	3	373	2	7.9	.8	2.63	2.02	68.61	1.049	5.56	4.79	2.71	Light green.
2	4	374	1	7.7	.8	1.42	1.06	68.13	1.052	5.44	5.37	3.64	Do.
3	5	400	1	7.7	1.0	1.43	1.29	67.06	1.053	6.13	5.73	1.57	Light green, starchy.
5	5	486	1	8.0	1.3	2.42	1.94	65.19	1.054	5.2[illegible]	5.31	3.10	Dark green, starchy.
9	6	592	1	8.5	.9	1.80	1.40	64.52	1.058	3.34	8.84	2.75	Do.
19	6	955	1	8.5	1.1	2.40	1.87	64.03	1.063	3.77	8.22	4.05	Do.
19	6	956	1	8.6	1.0	2.09	1.66	63.71	1.056	4.94	7.02	2.48	Do.
19	7	957	1	9.4	1.1	2.33	1.73	67.43	1.061	4.52	8.47	2.70	Do.
19	7	958	1	8.5	.9	1.85	1.40	62.99	1.063	4.64	7.70	3.79	Do.
19	8	959	1	7.6	1.0	2.38	1.62	62.60	1.065	4.32	9.28	2.93	Do.
19	8	960	1	9.0	.8	1.59	1.30	57.46	1.063	4.82	8.33	3.22	Do.
23	9	1113	1	9.6	1.1	2.99	2.17	64.34	1.060	4.71	7.95	2.39	Do.
23	9	1114	1	8.9	1.0	2.37	1.71	61.00	1.066	4.16	9.73	3.00	Do.
25	9	1235	1	9.5	1.1	2.93	2.11	64.89	1.065	4.26	9.78	2.25	Do.
25	9	1236	1	8.5	.9	1.81	1.25	64.65	1.070	3.50	11.03	3.09	Do.
30	10	1429	1	8.0	.9	2.10	1.49	63.12	1.063	3.95	9.67	2.51	Do.
30	10	1430	1	8.9	.9	2.00	1.36	65.16	1.063	4.32	9.31	2.55	Do.
Sept. 2	11	1589	1	8.4	1.1	1.80?	2.12	64.46	1.062	3.65	9.01	2.69	Dark green, some starch.
2	11	1590	1	8.1	1.0	1.91	1.33	64.08	1.069	3.18	10.75	3.24	Do.
8	12	1798	1	8.4	1.1	2.50	1.82	62.24	1.068	3.38	11.34	1.90	Dark green, starchy.
8	12	1799	1	8.9	1.0	2.18	1.58	69.03	1.066	3.35	10.96	1.63	Do.
15	13	2005	1	8.0	.9	1.96	1.37	66.72	1.071	2.82	10.12	4.29	Do.
15	13	2006	1	8.0	.9	1.89	1.38	63.59	1.078	2.16	13.61	3.39	Do.
23	14	2302	1	8.7	.9	1.94	1.25	62.13	1.073	2.26	11.78	3.71	Dark green, some starch.
23	14	2303	1	8.8	1.0	1.89	1.39	58.77	1.074	2.62	12.59	2.02	Do.
25	15	2498	1	9.1	1.0	2.90	2.03	57.03	1.075	1.80	12.71	4.00	Do.
25	15	2499	1	12.9	1.2	3.73	2.87	51.72	1.076	2.46	13.07	3.05	Do.
Oct. 6	16	2775	1	8.2	1.0	2.24	1.49	61.94	1.076	1.70	13.42	3.00	Dark green, starchy.
8	16	2863	1	8.0	1.2	2.99	2.15	64.62	1.072	2.58	12.62	2.64	Green.
15	17	3022	1	8.3	1.0	2.20	1.55	64.54	1.083	2.31	13.87	4.37	Dark green.
16	17	3059	1	7.3	.9	1.76	1.24	58.54	1.083	1.56	15.79	4.10	Very dark green.
22	17	3179	1	8.5	1.3	2.70	1.85	61.67	1.082	1.27	15.64	5.10	Dark green.
26	17	3243	1	8.4	1.0	2.00	1.57	60.67	1.085	1.50	18.82?	.71?	Do.
28	17	3289	1	9.0	1.1	2.29	1.83	60.00	1.083	1.27	15.93	4.22	Green.
28	18	3290	1	8.3	.9	1.65	1.25	60.04	1.081	1.68	14.28	4.53	Do.
Nov. 4	18	3412	1	8.8	1.1	1.80	1.47	61.94	1.080	1.25	14.38	3.17	Dark green.
6	18	3451	1	6.2	1.0	1.24	1.13	59.96	1.079	1.78	14.20	3.02	Do.
13	18	3521	1	9.0	.8	.99	.78	57.47	1.060	2.19	9.34	3.61	Dark olive.

* Topped.

ANALYSES OF JUICES FROM SORGHUM—Continued.

TABLE No. 29.—NEW VARIETY. J. W. H. SALLE, STRAFFORD, MO.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
July 26	1	180	1	8.4	0.9	1.82	1.34	59.74	1.034	5.44	2.30	2.30	Dark green.
26	2	181	1	8.0	.9	1.85	1.37	58.70	1.033	5.26	1.86	1.50	Do.
26	3	187	1	7.8	.9	1.78	1.36	60.02	1.033	5.32	1.86	1.58	Do.
30	4	294	1	8.7	.9	1.76	1.38	65.55	1.043	5.03	6.06?	.26?	Lighter green, starchy.
30	5	295	1	8.5	.9	2.15	1.68	66.40	1.039	5.01	2.99	1.96	Do.
31	5	339	1	8.5	.9	1.72	1.33	67.44	1.043	4.89	3.65	2.63	Do.
Aug. 3	6	395	1	8.8	.8	1.80	1.39	69.36	1.049	4.77	5.89	1.92	Light green, starchy.
6	7	520	1	9.7	1.0	2.07	1.69	77.81	1.045	4.96	4.51	2.01	Thin, watery.
9	8	584	1	9.0	1.0	1.97	1.25	78.03	1.050	4.69	6.20	2.11	Dark green, watery.
17	4	908	1	8.4	.7	1.05	.79	61.48	1.061	3.77	8.64	3.24	Dark green, starchy.
10	8	596	1	8.7	.9	1.83	1.32	65.33	1.055	4.13	7.73	2.93	Light green, starchy.
10	8	597	1	7.6	.7	1.13	.79	64.17	1.054	4.20	7.52	1.98	Dark green, starchy.
10	8	598	1	8.5	1.0	1.98	1.48	68.15	1.054	4.08	7.28	2.34	Do.
10	8	599	1	7.3	.9	1.67	1.21	65.85	1.051	4.83	6.01	2.00	Do.
11	8	670	1	8.7	.8	1.19	.89	78.52	1.052	4.22	7.17	2.01	Dark green, watery.
11	8	671	1	7.5	1.0	1.89	1.41	63.38	1.048	4.51	5.62	2.18	Dark green, starchy.
11	8	672	1	8.2	.9	1.72	1.23	65.48	1.054	4.03	7.32	2.26	Do.
11	8	673	1	7:6	.9	1.33	1.01	63.48	1.053	4.93	6.91	1.50	Do.
18	9	925	1	8.0	1.0	1.93	1.47	65.67	1.058	4.09	8.06	2.07	Do.
18	9	926	1	8.2	.9	1.70	1.24	65.94	1.063	3.90	9.00	2.48	Do.
18	9	927	1	8.0	.8	1.47	1.07	66.80	1.062	4.12	8.77	2.32	Do.
18	9	928	1	8.2	.9	1.25	.90	65.12	1.065	4.46	9.00	2.50	Do.
23	10	1097	1	12.0	1.2	3.[illegible]6	2.35	82.10?	1.038	4.46	4.07	1.44	Do.
23	10	1098	1	7.0	.9	1.54	.96	68.05	1.058	3.86	8.69	1.39	Do.
23	10	1099	1	7.7	1.1	2.24	1.62	68.59	1.037	3.31	4.34	1.99	Do.
23	10	1100	1	8.0	.8	1.29	1.49	41.04	1.056	4.19	7.99	1.93	Do.
23	9	1121	1	9.0	1.0	2.42	1.60	65.57	1.060	1.68	11.90	1.47	Do.
23	9	1122	1	8.0	1.0	1.72	1.19	62.04	1.059	2.16	10.11	2.51	Do.
25	10	1221	1	9.7	1.1	2.14	1.50	66.18	1.058	4.34	8.32	2.11	Do.
25	10	1222	1	8.0	.9	1.17	.79	62.50	1.065	3.46	10.70	2.13	Do.
25	10	1223	1	8.6	.9	1.68	1.10	78.29?	1.059	3.95	8.98	1.99	Do.
25	10	1224	1	8.3	.9	1.40	.95	61.96	1.062	4.48	9.05	1.96	Do.
28	11	1365	1	9.0	.9	1.65	1.08	69.61	1.053	3.85	7.62	2.11	Do.
28	11	1366	1	7.6	.8	1.18	1.05	49.27	1.064	3.62	10.00	2.64	Do.
28	11	1367	1	7.6	.8	1.14	.80	62.57	1.066	3.59	9.96	2.96	Do.
28	11	1368	1	8.4	.8	1.37	.94	64.94	1.061	4.15	8.71	2.60	Do.
Sept. 2	12	1573	1	8.3	1.1	2.02	1.49	68.62	1.040	3.61	5.29	2.53	Dark brown, some starch.
2	12	1574	1	7.[illegible]	.9	1.57	1.12	66.86	1.049	3.36	6.63	2.21	Do.
2	12	1575	1	8.[illegible]	.6	1.03	.68	63.24	1.058	3.78	8.15	1.92	Do.
2	12	1576	1	8.5	.7	1.95	.92	75.47?	1.048	4.09	5.79	2.10	Do.
21	13	2229	1	8.6	.9	1.52	1.16	60.57	1.071	2.58	11.12	3.62	Dark green, starchy.
21	13	2230	1	8.1	1.1	1.75	1.32	66.27	1.049	4.48	5.61	1.97	Dark green, some starch.
21	13	2231	1	8.0	.9	1.63	1.30	64.00	1.068	2.95	11.12	2.70	Do.
21	13	2232	1	7.5	.9	1.62	1.09	60.20	1.068	2.93	11.12	2.77	Do.
23	14	2342	1	9.8	1.0	1.72	1.28	58.29	1.072	2.93	12.06	2.69	Do.
23	14	2343	1	7.8	1.1	1.83	1.42	63.15	1.059	3.42	8.61	2.18	Do.
23	14	2344	1	9.0	1.0	1.60	1.16	61.93	1.070	2.86	11.38	2.86	Do.
23	14	2345	1	8.0	1.0	1.52	1.10	67.52	1.071	2.70	11.88	2.88	Do.
25	15	2482	1	8.0	.9	1.36	1.12	62.13	1.068	2.66	11.53	2.90	Do.
25	15	2483	1	9.0	.9	1.69	1.28	58.42	1.073	2.54	12.77	2.91	Do.
25	15	2484	1	8.5	1.0	1.72	1.21	58.33	1.076	2.29	13.54	3.08	Do.
25	15	2485	1	8.8	.9	1.60	1.20	60.64	1.070	2.80	11.72	3.14	Do.
28	16	2646	1	9.7	.9	1.50	1.04	60.80	1.074	2.56	12.91	2.59	Do.
28	16	2647	1	10.3	1.0	1.78	1.32	64.16	1.057	4.14	8.02	1.89	Do.
28	16	2648	1	8.0	.9	1.57	1.20	49.08	1.075	2.24	13.22	2.77	Do.
28	16	2649	1	7.6	.9	1.48	1.05	68.42	1.071	2.71	12.73	2.07	Do.
Oct. 1	16*	2705	1	6.0	1.0	1.86	1.46	46.33	1.077	2.77	13.02	3.06	Green.
5	16	2758	1	9.8	1.0	2.06	1.43	65.48	1.067	2.87	11.79	2.12	Light green.
7	16	2823	1	9.5	1.0	1.52	1.15	61.45	1.079	2.14	13.53	3.85	Green.
12	16	2938	1	10.0	1.0	1.98	1.38	61.84	1.078	2.17	13.71	3.38	Brownish green.
14	16	2985	1	9.3	.9	1.91	1.05	60.00	1.077	1.73	13.75	3.13	Dark green.
15	16	3016	1	9.5	1.0	1.96	1.47	64.17	1.074	2.26	12.78	4.23	Do.
16	17	3053	1	11.0	1.0	1.89	1.32	61.33	1.084	1.99	14.56	4.48	Very dark green.
19	17	3110	1	7.9	1.1	1.91	1.40	62.54	1.085	1.75	14.98	4.34	Dark green.
21	18	3142	1	8.0	.9	1.19	.86	60.76	1.069	2.16	11.22	3.88	Dirty green.

* Topped August 28.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Oct. 22	17	3173	1	9.6	0.8	1.30	1.02	53.03	1.080	2.33	13.57	4.15	Light green.
26	17	3237	1	8.4	.9	1.23	1.06	60.74	1.074	2.50	13.50	2.06	Do.
28	18	3295	1	8.0	.7	.86	.63	59.03	1.073	2.50	12.45	2.90	Green.
29	18	3326	1	6.5	.9	1.07	.69	62.74	1.074	2.18	12.01	3.64	Very light green.
Nov. 2	18	3371	1	8.0	.9	......	1.09	63.23	1.070	2.02	13.05	2.26	Light greten.
4	17	3406	1	8.0	1.0	1.54	1.33	56.29	1.077	1.51	13.36	3.61	Dark green.
5	18	3437	1	5.8	1.1	1.47	1.28	60.14	1.067	1.92	12.09	3.19	Do.
4	18	3515	1	7.0	.9	1.00	.86	65.13	1.071	2.10	11.91	2.94	Do.

TABLE No. 30.—SUMAC. J. H. WIGHTON, MOUNT OLIVE, ALA.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
Aug. 2	1	375	2	7.2	1.0	3.54	2.73	65.81	1.049	6.67	3.85	2.11	Light green.
2	2	376	1	8.5	1.0	2.08	1.63	65.27	1.045	6.07	3.70	2.10	Do.
2	3	377	1	8.3	1.0	2.02	1.58	68.20	1.048	6.48	3.64	2.14	Do.
2	4	378	1	8.4	.9	1.79	1.39	66.61	1.048	5.84	4.26	2.30	Do.
5	4	485	1	8.0	1.2	2.21	1.78	62.39	1.053	5.06	5.70	2.73	Dark green, starchy.
19	6	967	1	8.3	.8	1.35	1.05	62.82	1.060	5.07	7.70	2.65	Do.
19	6	968	1	8.5	.9	1.70	1.34	65.35	1.055	5.15	6.56	2.46	Do.
19	7	969	1	8.5	1.0	2.21	1.78	64.69	1.060	4.78	7.56	3.18	Do.
19	7	970	1	9.0	1.1	2.51	2.01	66.67	1.059	4.73	7.70	2.96	Do.
19	8	971	1	9.2	.9	2.03	1.60	62.55	1.062	4.28	8.68	2.67	Do.
19	8	972	1	8.5	.9	2.24	1.76	65.73	1.062	4.25	9.10	2.42	Do.
23	9	1111	1	9.5	.8	1.21	.88	66.83	1.059	1.70	10.70	2.43	Do.
23	9	1112	1	9.1	.9	1.96	1.36	62.90	1.061	4.18	8.84	2.48	Do.
25	9	1233	1	9.7	1.1	2.83	2.01	64.95	1.061	3.62	9.79	2.19	Do.
25	9	1234	1	9.6	1.0	2.26	1.58	63.13	1.062	4.05	9.36	2.22	Do.
30	10	1427	1	8.9	.9	1.62	1.14	64.61	1.061	4.15	9.00	2.50	Do.
30	10	1428	1	8.7	.8	1.96	1.30	64.83	1.061	3.98	9.42	2.15	Do.
Sept. 2	11	1587	1	9.2	1.0	1.69	1.30	67.59	1.059	4.24	8.20	2.43	Dark green, some starch.
2	11	1588	1	9.2	1.0	1.94	1.31	66.67	1.060	3.94	8.80	2.36	Do.
7	12	1793	1	9.4	1.2	3.03	2.09	64.45	1.067	3.37	9.99	2.77	Dark green, starchy.
7	12	1794	1	9.0	.9	1.70	1.18	63.34	1.064	3.40	10.15	2.28	Do.
15	13	2003	1	8.2	1.3	2.75	1.97	64.77	1.071	3.18	9.33	4.93	Do.
15	13	2004	1	8.0	1.0	1.91	1.33	64.17	1.073	2.78	11.29	3.92	Do.
22	14	2295	1	9.4	1.1	2.48	1.84	58.85	1.070	2.65	12.26	2.52	Dark green, some starch.
22	14	2296	1	9.0	1.0	1.69	1.35	59.34	1.073	2.70	13.26	2.21	Do.
25	14	2496	1	8.7	1.1	2.42	1.56	63.09	1.074	2.53	11.97	3.98	Do.
25	14	2497	1	9.4	1.1	2.15	1.65	56.95	1.074	2.33	12.21	4.22	Do.
Oct. 6	15	2774	1	8.9	1.1	2.92	2.04	61.70	1.079	1.24	11.26	5.94	Dark green, starchy.
8	15	2862	1	8.3	1.1	2.18	1.51	58.10	1.087	2.18	....	....	Green.
15	16	3021	1	8.9	1.1	2.59	1.84	63.64	1.083	2.35	14.32	4.38	Dark green.
16	16	3058	1	8.0	.9	1.92	1.42	65.07	1.083	1.65	14.33	4.90	Very dark green.
22	16	3178	1	8.0	1.1	2.18	1.57	60.00	1.084	1.90	15.01	3.40	Dark green.
26	16	3242	1	8.9	1.1	1.79	1.50	60.82	1.083	2.42	16.06	2.02	Do.
4	17	3413	1	9.0	1.1	1.57	1.32	55.83	1.076	1.82	13.74	2.74	Do.
13	17	3520	1	7.5	.9	1.65	1.20	62.76	1.076	1.21	13.97	3.48	Do.

TABLE No. 31.—HONDURAS. ARSENAL GROUNDS.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
July 22	1	107	2	7.4	0.8	2.87	1.97	36.12	1.032	3.39	8.40?	3.80?	
24	1	152	1	7.8	.9	1.62	1.16	54.71	1.028	3.71	1.31	2.32	Brownish.
26	2	179	1	9.5	.9	1.20	.89	49.01	1.028	3.28	1.99	1.78	Dark green.
26	3	201	2	8.5	.8	2.66	1.98	48.94	1.038	3.16	4.27	2.10	Dark green, starchy.
26	4	202	2	9.0	.7	1.80	1.29	40.75	1.042	3.90	3.82	2.79	Do.
30	5	293	1	10.1	.7	2.10	1.63	64.50	1.044	3.08	5.60	2.34	Lighter green, starchy.
Aug. 2	6	363	1	10.8	1.1	1.69	1.32	56.00	1.045	2.83	5.77	2.93	Do.
6	7	519	1	10.5	1.0	1.42	1.14	68.85	1.041	5.13	3.08	2.02	Thin, watery.
7	8	550	1	9.7	.8	1.13	.79	57.42	1.049	3.31	5.53	3.08	Darker green watery.
9	8	582	1	10.1	.9	2.10	1.65	68.88	1.043	2.04	7.01	1.88	Thin, watery.
10	9	606	1	11.2	1.0	1.27	.90	50.00	1.051	2.47	7.01	3.03	Dark green, starchy.
10	9	607	1	10.5	.9	1.71	1.26	55.85	1.053	1.12	8.64	3.06	Do.
10	9	608	1	10.0	1.1	1.44	1.09	54.73	1.051	2.21	7.34	2.91	Do.
10	9	609	1	9.1	1.0	1.77	1.32	70.34	1.048	4.47	5.84	1.71	Dark green, watery.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Aug. 14	8	799	1	6.5	0.9	2.11	1.81	57.71	1.051	1.11	Lost.	Lost.	Dark green, watery.
14	8	800	1	10.4	1.0	1.88	1.42	68.37	1.052	3.15	7.51	2.41	Do.
14	8	801	1	9.7	1.2	1.54	1.02	59.13	1.051	2.37	7.33	2.81	Do.
14	8	802	1	10.0	.9	1.36	.96	53.10	1.052	1.37	8.45	2.73	Do.
17	9	903	1	10.3	1.3	2.24	1.88	72.01	1.034	3.76	2.58	2.22	Dark green, starchy.
17	9	904	1	10.0	1.2	1.41	.99	48.00	1.051	1.38	7.99	2.95	Do.
17	9	905	1	10.2	.8	1.22	.87	50.15	1.055	1.19	10.77	1.41	Do.
17	9	906	1	11.3	.9	1.82	1.46	67.37	1.047	3.78	6.06	1.91	Do.
23	9	1089	1	10.0	1.0	1.37	.95	48.58	1.051	2.31	7.34	2.72	Do.
23	9	1090	1	10.0	1.1	2.16	1.62	72.52	1.042	4.20	4.53	2.45	Do.
23	9	1091	1	8.5	1.0	1.36	.92	53.12	1.050	1.07	8.50	3.00	Do.
23	9	1092	1	11.0	.9	1.14	.81	47.97	1.045	1.91	5.64	3.17	Do.
25	10	1213	1	12.0	.9	1.72	1.16	54.63	1.047	2.87	6.26	2.91	Do.
25	10	1214	1	9.2	.9	1.39	.94	49.54	1.050	1.37	8.25	2.90	Do.
25	10	1215	1	8.2	.9	1.32	.80	46.96	1.046	.84	7.58	2.77	Dark brown, starchy.
25	10	1216	1	12.1	1.0	1.32	.91	48.68	1.050	2.39	6.59	3.16	Dark green, starchy.
28	11	1361	1	7.7	1.0	2.38	1.64	69.04	1.022	3.06	1.46	1.11	Dark brown, watery.
28	11	1362	1	9.9	1.1	2.18	1.66	66.63	1.065	2.37	8.73	2.79	Dark green, starchy.
28	11	1363	1	9.7	1.0	1.45	.98	54.15	1.038	2.61	3.95	2.50	Dark green, watery.
28	11	1364	1	10.4	1.0	1.58	1.21	67.03	1.043	4.61	4.38	2.04	Do.
Sept. 2	12	1565	1	10.3	1.0	1.52	.97	50.45	1.032	1.21	3.45	2.70	Dark green, some starch.
2	12	1566	1	11.6	.9	1.36	.88	55.97	1.042	1.76	5.84	2.14	Do.
2	12	1567	1	10.1	.9	1.25	.83	47.60	1.035	2.07	3.54	2.75	Dark brown, some starch.
2	12	1568	1	9.5	1.0	1.22	.86	44.72	1.062	1.93	9.23	3.29	Do.
6	12	1721	1	10.6	.9	1.61	1.04	46.41	1.030	2.28	2.97	2.37	Dark green, some starch.
6	12	1722	1	9.6	.6	.84	.75	29.49	1.053	.95	6.73	4.28	Do.
6	12	1723	1	9.9	1.2	1.69	1.21	54.19	1.047	2.33	5.80	3.19	Do.
6	12	1724	1	9.7	.9	1.42	.89	47.77	1.056	1.10	8.22	4.22	Do.
14	13	1969	1	11.3	1.2	2.29	1.86	69.54	1.048	4.53	5.59	1.00	Light green, some starch.
14	13	1970	1	11.0	1.1	1.69	1.46	67.57	1.047	3.64	6.09	1.78	Do.
14	13	1971	1	10.7	1.0	1.29	1.04	68.14	1.045	4.46	4.78	1.67	Do.
14	13	1972	1	9.8	1.0	1.09	.80	44.47	1.053	2.62	6.69	2.98	Do.
21	14	2221	1	10.8	.7	.68	.43	46.19	1.052	2.19	7.25	2.11	Thin, watery.
21	14	2222	1	10.3	1.0	1.91	1.64	60.04	1.073	2.16	12.67	2.88	Do.
21	14	2223	1	9.1	.8	1.17	.79	46.32	1.064	2.11	9.15	3.86	Do.
21	14	2224	1	9.0	1.1	1.11	.74	41.96	1.069	.82	12.11	3.46	Do.
23	15	2334	1	10.6	1.2	3.17	2.44	64.59	1.062	2.54	10.56	2.01	Dark green, some starch.
23	15	2335	1	12.6	1.2	2.57	2.24	67.05	1.057	2.48	6.47	5.00	Do.
23	15	2336	1	9.2	.9	1.05	.74	47.44	1.066	1.35	11.06	3.30	Do.
23	15	2337	1	8.1	.8	1.12	.81	49.04	1.058	2.33	8.79	2.77	Do.
25	15	2474	1	11.6	1.1	2.24	1.82	64.00	1.065	2.37	11.48	2.72	Do.
25	15	2475	1	10.4	1.2	1.87	1.58	65.04	1.045	4.43	5.00	2.10	Do.
25	15	2476	1	11.6	1.2	2.40	2.06	65.02	1.061	3.35	9.98	2.27	Do.
25	15	2477	1	12.0	1.2	2.28	1.96	64.15	1.063	2.96	10.55	2.72	Do.
28	16	2638	1	11.6	1.0	1.69	1.24	46.97	1.056	.96	9.50	2.61	Do.
28	16	2639	1	9.6	1.1	1.43	.90	48.53	1.054	1.52	8.27	2.78	Do.
28	16	2640	1	11.3	1.2	2.46	1.91	67.43	1.061	3.12	9.50	2.46	Do.
28	16	2641	1	10.3	1.0	1.25	.88	44.97	1.062	1.81	9.93	3.14	Do.
Oct. 1	16*	2703	1	7.5	1.2	1.70	1.47	69.70	1.056	2.89	6.77	4.30	Green.
5	16	2756	1	13.4	1.3	3.60	2.78	68.30	1.060	2.77	10.59	1.87	Very light green.
7	16	2821	1	13.6	1.3	3.06	2.66	71.19	1.059	3.31	9.06	2.45	Green.
12	16	2936	1	9.6	.8	.92	.61	44.44	1.072	1.28	12.12	4.49	Light green, starchy.
14	16	2983	1	11.5	1.0	1.99	1.81	65.08	1.070	3.15	10.94	2.97	Light green.
15	18	3014	1	11.9	1.0	1.59	1.28	64.66	1.054	3.36	7.40	3.38	Brown.
16	17	3051	1	13.0	1.0	2.16	1.89	66.63	1.071	2.68	11.81	3.72	Dark green.
19	17	3108	1	9.5	.8	1.06	.76	50.14	1.069	1.12	11.57	3.96	Dirty green.
20	17	3135	1	11.5	1.1	1.89	1.76	63.75	1.074	2.86	12.56	3.71	
22	18	3171	1	9.5	1.0	1.43	.99	42.92	1.060	.94	9.54	4.19	Dark straw.
26	18†	3235	1	6.8	1.2	......	1.84	65.27	1.066	3.40	9.80	3.04	Light green.
28	17	3203	1	10.3	1.0	1.36	1.02	47.62	1.072	1.14	12.54	3.76	Green.
29	17	3324	1	9.6	1.1	2.04	1.65	67.25	1.073	2.42	12.60	2.45	Light green.
Nov. 2	18	3385	1	12.8	1.1	......	1.15	47.14	1.065	1.56	10.73	.39	Do.
4	17	3404	1	11.5	1.5	2.06	1.97	66.33	1.073	2.74	12.05	2.73	Yellowish green.
5	18†	3435	1	6.8	1.0	1.56	1.54	65.76	1.064	2.54	11.43	3.09	Do.
13	18†	3513	1	5.8	.9	.76	.71	48.76	1.049	1.22	6.88	3.24	Brown.

* Topped August 28. † Topped.

ANALYSES OF JUICES FROM SORGHUM—Continued.

TABLE No. 32.—HONEY CANE. J. H. CLARK, PLEASANT HILL, LA.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
July 30	1	290	1	7.7	1.2	2.79	2.26	66.15	1.036	4.72	2.74	2.00	Brownish.
30	2	291	1	8.1	1.1	2.95	2.39	66.69	1.034	4.61	2.38	1.67	Lighter brown.
Aug. 4	3	433	1	9.1	1.1	2.74	2.14	69.34	1.037	4.63	5.54?	.86?	Light green, starchy.
6	3	516	1	9.7	1.2	2.54	2.10	71.28	1.033	4.50	1.72	2.25	Thin, watery.
7	4	544	1	9.8	1.3	3.08	2.47	65.81	1.038	4.61	3.74	1.57	Light green, watery.
9	5	578	1	9.1	1.2	2.95	2.33	67.11	1.043	4.71	4.66	1.80	Watery, some starch.
11	4	654	1	10.0	1.3	3.10	2.56	71.37	1.035	4.75	2.70	1.63	Dark green, watery.
11	4	655	1	10.5	1.1	3.01	2.40	60.60	1.038	4.73	2.35	2.75	Do.
11	4	656	1	10.3	1.3	3.37	2.74	69.08	1.033	4.68	2.45	1.58	Do.
11	4	657	1	9.6	1.3	3.21	2.59	65.17	1.038	4.43	3.57	2.02	Do.
14	5	783	1	10.9	1.0	2.68	2.10	60.83	1.041	4.33	4.71	1.72	Dark green.
14	5	784	1	11.5	1.2	2.87	2.51	69.00	1.041	4.31	4.58	1.68	Do.
14	5	785	1	11.5	1.1	2.93	2.36	70.70	1.042	4.63	4.45	1.86	Do.
14	5	786	1	10.0	1.1	2.60	2.05	70.00	1.043	4.48	4.92	1.72	Do.
17	5	887	1	11.0	1.1	2.75	2.20	70.62	1.043	Lost.	Lost.	Lost.	Dark green, watery.
17	5	888	1	11.2	1.1	2.86	2.39	69.98	1.043	4.30	4.62	1.91	Do.
17	5	889	1	11.9	1.1	2.75	2.30	69.70	1.043	4.77	4.10	2.06	Do.
17	5	890	1	10.6	1.2	2.93	2.42	71.00	1.040	Lost.	Lost.	Lost.	Do.
18	5	913	1	11.0	1.3	3.20	2.60	70.93	1.040	4.21	4.00	1.93	Do.
18	5	914	1	11.0	1.1	2.61	2.13	74.95	1.040	4.51	3.92	1.71	Do.
18	5	915	1	11.5	1.1	3.09	2.51	69.55	1.045	4.45	5.20	1.79	Do.
18	5	916	1	10.4	1.2	2.32	1.93	68.80	1.043	4.37	4.54	1.97	Do.
21	6	1068	1	11.0	1.1	2.75	2.25	72.66	1.045	3.89	5.97	1.86	Thin, watery.
21	6	1069	1	11.8	1.1	2.79	2.32	70.30	1.044	4.31	5.23	2.05	Do.
21	6	1070	1	11.5	1.1	2.97	2.46	70.52	1.047	4.34	6.55	1.38	Do.
21	6	1071	1	9.8	1.0	2.08	1.77	67.00	1.048	4.88	5.80	1.49	Do.
25	7	1201	1	12.4	1.1	3.59	2.68	68.54	1.049	3.28	7.41	1.89	Dark green, starchy.
25	7	1202	1	12.3	1.2	3.05	Lost.	Lost.	1.045	4.17	5.97	1.68	Do.
25	7	1203	1	12.2	1.1	2.70	2.18	70.00	1.047	4.24	6.52	1.42	Do.
25	7	1204	1	12.4	1.1	2.47	Lost.	Lost.	1.048	4.35	6.51	1.40	Do.
27	8	1331	1	12.1	1.1	2.72	2.18	69.89	1.055	3.65	7.44	2.89	Do.
27	8	1332	1	12.0	1.3	3.09	2.60	67.07	1.050	4.07	6.45	2.19	Do.
27	8	1333	1	11.5	1.2	2.97	2.36	59.18	1.055	3.58	7.87	2.41	Do.
27	8	1334	1	11.4	1.0	2.83	2.22	69.74	1.051	4.00	6.80	2.14	Do.
Sept. 2	9	1553	1	12.1	1.1	3.05	2.46	60.71	1.054	3.56	7.55	2.22	Dark green, some starch.
2	9	1554	1	12.7	1.1	3.30	2.63	71.15	1.052	3.53	8.05	1.35	Do.
2	9	1555	1	13.3	1.1	3.50	2.83	64.36	1.053	3.80	8.23	1.22	Do.
2	9	1556	1	9.7	1.0	2.90	2.26	70.82	1.051	4.03	7.26	1.17	Do.
6	10	1705	1	11.7	1.0	2.54	2.02	69.74	1.061	2.73	10.43	2.25	Dark green, starchy.
6	10	1706	1	12.1	1.1	2.89	2.38	69.01	1.056	3.40	9.05	1.99	Do.
6	10	1707	1	11.3	1.3	3.01	2.26	69.26	1.051	3.71	8.24	1.13	Do.
6	10	1708	1	10.4	1.2	2.59	2.08	70.58	1.050	3.49	7.27	1.53	Do.
14	11	1953	1	12.8	1.3	3.14	2.59	66.97	1.060	2.77	9.81	1.90	Light green, some starch.
14	11	1954	1	11.9	1.2	2.97	2.48	68.14	1.057	3.09	9.11	2.08	Do.
14	11	1955	1	11.6	1.2	2.71	2.21	59.90	1.057	3.22	8.56	1.94	Do.
14	11	1956	1	11.9	1.3	3.05	1.54	64.14	1.050	4.82	5.89	1.34	Do.
17	10	2094	1	12.2	1.2	4.16	3.16	65.01	1.064	2.82	10.60	2.41	Dark green, starchy.
17	10	2095	1	13.5	1.0	2.57	2.29	69.00	1.055	2.93	9.38	1.62	Do.
17	10	2096	1	11.8	1.3	2.79	1.97	69.49	1.049	4.71	6.11	1.72	Do.
17	10	2097	1	11.3	1.3	2.64	2.38	68.61	1.058	2.94	8.54	3.17	Do.
21	11	2209	1	12.0	1.0	2.72	2.29	64.80	1.063	2.12	11.39	2.25	Thin, watery.
21	11	2210	1	12.6	1.1	2.55	2.01	67.43	1.055	3.35	8.95	1.44	Do.
21	11	2211	1	11.1	1.3	2.55	2.32	69.31	1.058	2.61	9.53	2.23	Do.
21	11	2212	1	12.0	.9	1.94	1.60	61.74	1.065	2.68	11.08	2.30	Do.
23	12	2318	1	13.2	1.0	2.65	2.28	66.08	1.063	2.42	10.88	1.36	Dark green, some starch.
23	12	2319	1	10.4	1.6	4.68	3.94	66.31	1.060	3.38	13.80	2.05	Dark green, watery.
23	12	2320	1	13.3	1.2	2.73	2.33	66.54	1.059	3.01	10.04	1.59	Do.
23	12	2321	1	11.0	1.2	2.64	2.32	66.19	1.063	2.46	10.43	2.45	Do.
25	13	2462	1	13.4	1.0	2.66	2.24	68.66	1.049	3.50	7.78	1.49	Dark green, some starch.
25	13	2463	1	13.7	1.2	2.90	2.62	65.89	1.061	2.75	10.28	2.57	Do.
25	13	2464	1	12.8	1.0	1.76	1.35	62.43	1.068	2.76	10.89	2.38	Do.
25	13	2465	1	10.3	1.0	2.11	1.84	67.66	1.050	4.17	6.44	2.06	Do.
28	14	2622	1	12.0	1.2	2.84	2.30	63.92	1.065	1.94	11.64	2.38	Do.
28	14	2623	1	11.1	1.3	2.91	2.46	67.88	1.059	2.99	9.21	2.39	Do.
28	14	2624	1	12.0	1.3	3.08	2.60	67.11	1.063	2.40	10.92	2.21	Do.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Sept. 28	14	2624	1	11.0	1.1	2.21	2.01	57.15	1.046	4.41	5.39	1.58	Dark green, some starch.
Oct. 1	15*	2699	1	9.2	1.5	3.10	2.59	65.56	1.071	1.69	12.92	3.05	Green, turbid.
4	15	2749	1	12.3	1.3	2.90	2.56	61.45	1.069	1.67	12.72	3.21	Very light green.
7	15	2817	1	13.0	1.1	2.78	1.11	65.47	1.058	2.95	8.96	2.55	Green.
12	15	2932	1	13.3	1.1	3.35	2.82	63.34	1.069	1.46	12.74	3.29	Light green, starchy.
13	15	2979	1	12.2	1.1	2.11	1.97	67.72	1.066	2.72	11.56	2.23	Light green.
15	16	3011	1	12.6	1.3	2.83	2.46	63.48	1.071	1.47	13.15	4.05	Do.
16	16	3048	1	12.9	1.1	2.07	1.83	61.54	1.071	1.67	12.65	3.25	Dark green.
19	16	3105	1	12.3	1.1	2.53	2.24	66.92	1.070	1.55	12.79	3.21	Light green.
20	16	3132	1	10.6	1.1	2.48	2.22	65.05	1.069	1.83	12.64	3.72	
22	17	3167	1	12.9	1.0	1.96	1.74	60.28	1.078	1.59	13.11	5.10	Dark straw.
25	17	3222	1	12.3	1.2	2.28	2.18	64.18	1.076	2.09	12.96	3.05	Light green.
27	17	3278	1	12.0	1.2	2.26	2.19	65.66	1.076	2.21	13.41	3.12	Do.
29	17	3317	1	10.7	1.1	1.91	1.73	65.61	1.074	2.36	12.47	2.77	Very light brown.
30	17	3347	1	12.5	1.3	2.68	2.40	67.11	1.070	1.58	12.60	3.86	Light green.
Nov. 3	17	3396	1	11.6	1.1	2.37	2.26	62.79	1.079	2.73	12.83	4.18	Do.
5	18†	3432	1	5.7	1.4	2.53	2.44	69.40	1.060	1.86	11.00	2.14	Dark green.
10	18	3489	1	11.0	1.3	2.74	2.68	70.58	1.065	2.41	11.16	3.09	Yellowish green.
12	18	3510	1	11.3	1.1	2.12	2.01	67.87	1.063	2.41	10.49	3.59	Light green.
15	18	3539	1	6.5	1.2	1.73	1.64	70.82	1.049	3.76	5.93	2.18	Yellowish green.

TABLE No. 33.—SPRANGLE TOP. WILLIS POPE, ALA.

	1	393	1	8.0	1.2	2.36	1.79	69.61	1.036	5.07	7.49?	1.66	Light green, starchy.
4	1	434	1	8.2	1.1	2.48	1.85	70.37	1.034	5.07	2.13	1.60	Do.
7	2	545	1	8.9	1.2	2.79	2.17	68.39	1.036	4.83	2.45	2.04	Light green, watery.
9	3	580	1	9.0	1.1	2.56	1.99	68.80	1.039	5.11	3.23	1.67	Watery, some starch.
11	1	662	1	9.4	1.2	2.40	1.93	69.83	1.024	3.89	.71	1.85	Dark green, watery.
11	1	663	1	9.4	1.1	2.30	1.80	70.95	1.034	4.76	2.53	1.46	Do.
11	1	664	1	8.9	1.1	2.45	1.93	70.90	1.036	4.75	2.96	1.94	Do.
11	1	665	1	9.0	.9	2.22	1.58	68.19	1.038	5.15	3.25	1.28	Do.
14	2	791	1	11.0	1.1	2.88	2.23	70.97	1.034	4.56	1.98	2.26	Do.
14	2	792	1	10.6	1.1	2.57	1.99	69.76	1.035	4.35	2.14	2.40	Do.
14	2	793	1	10.5	1.0	2.70	2.12	63.83	1.039	5.03	2.54	2.44	Do.
14	2	794	1	10.0	1.0	2.04	1.88	60.29	1.037	4.71	2.67	2.31	Do.
17	2	895	1	10.6	1.0	2.05	1.63	70.54	1.041	4.68	3.89	1.76	Dark green, starchy.
17	2	896	1	11.2	1.3	2.75	2.28	68.00	1.040	4.97	3.44	1.45	Do.
17	2	897	1	11.0	1.0	2.29	1.85	67.62	1.038	5.10	2.74	1.75	Do.
17	2	898	1	11.0	1.1	2.88	2.38	68.95	1.039	4.53	3.63	1.50	Do.
21	3	1076	1	11.0	.9	1.86	1.48	71.80	1.036	4.61	3.30	1.45	Thin, watery.
21	3	1077	1	11.1	1.0	2.04	1.61	70.29	1.040	4.82	4.28	1.24	Do.
21	3	1078	1	10.7	.9	1.95	1.60	69.93	1.043	4.91	4.78	1.34	Do.
21	3	1079	1	11.0	1.0	1.84	1.50	72.73	1.037	4.40	3.31	2.27	Do.
25	4	1209	1	11.6	1.0	1.94	1.52	69.38	1.041	5.34	3.71	1.66	Dark green, starchy.
25	4	1210	1	11.5	1.1	2.00	1.60	69.33	1.043	5.66	3.96	1.65	Do.
25	4	1211	1	11.7	1.1	2.26	1.77	73.13	1.043	5.46	4.19	1.57	Do.
25	4	1212	1	11.0	1.0	1.74	1.42	66.82	1.049	5.90	4.97	1.95	Do.
28	5	1353	1	10.8	.9	1.51	1.16	68.00	1.045	5.33	4.73	1.71	Dark green, watery,
28	5	1354	1	12.2	1.1	2.34	1.90	70.92	1.046	5.00	4.85	2.10	Do.
28	5	1355	1	10.3	.8	1.45	1.11	70.69	1.042	4.89	4.33	1.82	Do.
28	5	1356	1	10.9	1.0	1.95	1.52	69.07	1.046	5.80	4.42	1.60	Do.
30	6	1395	1	12.3	1.0	2.29	1.87	69.69	1.051	4.56	6.75	2.11	Dark green, some starch.
30	6	1396	1	12.5	1.0	2.52	1.86	76.86	1.055	4.61	7.59	1.92	Do.
30	6	1397	1	12.0	1.0	2.06	1.68	69.03	1.045	5.02	5.14	1.85	Do.
30	6	1398	1	12.1	1.0	2.06	1.63	69.27	1.048	4.51	6.16	1.84	Do.
30	7	1403	1	12.6	1.0	2.26	1.85	70.84	1.049	4.51	6.49	1.87	Do.
30	7	1404	1	12.6	1.1	2.61	2.10	70.26	1.050	4.79	6.17	2.18	Do.
30	7	1405	1	12.0	1.0	1.86	1.52	69.27	1.050	4.58	6.62	1.90	Do.
30	7	1406	1	12.6	1.1	2.63	2.10	67.57	1.054	4.68	7.04	2.13	Do.
30	8	1411	1	13.8	1.1	3.04	2.42	69.06	1.051	4.28	7.01	2.22	Do.
30	8	1412	1	11.3	1.0	2.14	1.60	73.45	1.058	3.85	7.68	3.45	Do.
30	8	1413	1	12.0	1.0	2.32	1.81	67.52	1.055	4.53	7.50	2.38	Do.
30	8	1414	1	12.8	1.2	3.03	2.38	69.02	1.052	4.35	6.70	2.69	Do.
30	9	1419	1	11.9	1.1	2.62	2.02	70.99	1.050	4.43	6.67	1.71	Do.
30	9	1420	1	11.0	1.2	2.75	1.74	69.19	1.058	3.79	8.63	2.37	Do.
30	9	1421	1	10.9	1.1	2.80	2.17	67.99	1.055	4.23	7.63	2.26	Do.
30	9	1422	1	11.0	1.1	2.81	2.21	68.30	1.059	3.95	8.78	2.38	Do.

*Topped August 28. †Topped.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Sept. 2	10	1561	1	11. 2	1. 2	2. 25	1. 78	69. 55	1. 050	3. 75	7. 11	1. 81	Dark green, some starch.
2	10	1562	1	11. 2	1. 1	2. 64	2. 03	70. 82	1. 055	3. 82	7. 30	2. 48	Do.
2	10	1563	1	11. 4	1. 1	2. 18	1. 66	74. 50	1. 053	3. 99	7. 05	2. 07	Do.
2	10	1564	1	10. 8	1. 1	2. 34	1. 82	68. 96	1. 057	3. 62	9. 14	1. 15	Do.
6	10	1713	1	12. 5	1. 1	2. 60	2. 12	71. 08	1. 057	3. 16	9. 58	1. 88	Dark green, starchy.
6	10	1714	1	11. 0	1. 1	2. 31	1. 80	67. 97	1. 055	4. 06	8. 41	1. 51	Do.
6	10	1715	1	11. 4	1. 3	2. 68	2. 17	70. 96	1. 053	3. 83	8. 09	1. 52	Do.
6	10	1716	1	11. 0	1. 1	2. 36	1. 89	68. 85	1. 056	3. 84	8. 46	2. 14	Do.
14	11	1961	1	11. 2	1. 3	2. 55	2. 14	71. 40	1. 050	4. 14	5. 57	2. 58	Light green, some starch.
14	11	1962	1	10. 5	1. 0	1. 58	1. 32	56. 83	1. 049	5. 42	4. 70	1. 70	Do.
14	11	1963	1	10. 0	1. 1	1. 88	1. 53	69. 20	1. 057	3. 44	8. 57	1. 33	Do.
14	11	1964	1	10. 5	1. 4	3. 25	2. 68	64. 31	1. 054	3. 14	8. 28	1. 72	Do.
21	12	2217	1	12. 8	1. 1	2. 05	1. 69	63. 20	1. 056	4. 06	8. 29	1. 61	Thin, watery.
21	12	2218	1	12. 0	1. 1	2. 01	1. 67	66. 53	1. 051	4. 28	6. 67	1. 75	Do.
21	12	2219	1	12. 0	1. 1	2. 12	1. 80	65. 60	1. 061	3. 74	9. 75	1. 44	Do.
21	12	2220	1	10. 2	1. 3	3. 07	2. 55	63. 70	1. 064	1. 84?	9. 41	4. 59?	Do.
23	13	2326	1	12. 5	1. 2	2. 46	2. 01	65. 85	1. 043	4. 29	5. 15	1. 25	Dark green, watery.
23	13	2327	1	10. 0	1. 1	1. 89	1. 51	66. 13	1. 058	3. 17	8. 55	2. 55	Do.
23	13	2328	1	11. 9	1. 1	2. 49	2. 17	63. 49	1. 066	2. 04	11. 76	2. 71	Dark green, some starch.
23	13	2329	1	12. 1	1. 2	2. 90	2. 20	63. 72	1. 063	1. 63	9. 81?	4. 97?	Do.
25	13	2470	1	11. 8	1. 2	2. 36	1. 96	63. 82	1. 068	2. 07	12. 70	2. 42	Do.
25	13	2471	1	11. 5	1. 2	2. 60	2. 09	66. 67	1. 061	2. 94	9. 98	2. 44	Do.
25	13	2472	1	11. 4	1. 2	2. 26	1. 90	66. 58	1. 060	2. 95	9. 67	2. 86	Do.
25	13	2473	1	11. 9	1. 1	2. 29	2. 03	64. 43	1. 066	2. 37	11. 63	2. 79	Do.
28	14	2630	1	12. 8	1. 1	2. 09	1. 73	56. 22	1. 055	4. 05	7. 92	1. 82	Do.
28	14	2631	1	11. 8	1. 1	2. 09	1. 71	64. 04	1. 064	2. 70	10. 54	2. 56	Do.
28	14	2632	1	10. 0	1. 1	2. 19	1. 28	64. 31	1. 070	1. 88	12. 48	2. 70	Do.
28	14	2633	1	10. 6	1. 3	3. 33	2. 60	63. 85	1. 070	1. 54	13. 18	2. 48	Do.
Oct. 1	14*	2701	1	9. 0	1. 2	2. 45	1. 96	69. 05	1. 068	1. 81	12. 11	3. 18	Green.
5	15	2754	1	12. 0	1. 3	3. 92	3. 20	68. 33	1. 040	4. 28	4. 73	1. 37	Very light green.
7	15	2819	1	10. 6	1. 0	1. 90	1. 60	58. 82	1. 058	3. 66	8. 24	2. 56	Green.
12	15	2934	1	12. 4	1. 1	2. 61	2. 24	70. 60	1. 062	2. 82	10. 51	2. 35	Light green, starchy
13	15	2981	1	11. 9	1. 0	2. 04	1. 71	65. 69	1. 071	2. 35	12. 34	2. 88	Light green.
15	17	3013	1	12. 8	1. 2	2. 95	2. 57	68. 21	1. 076	1. 88	11. 95	2. 99	Do.
16	16	3050	1	11. 9	1. 0	1. 67	1. 44	73. 28	1. 069	3. 10	11. 16	3. 93	Dark green.
19	16	3107	1	11. 4	1. 1	2. 49	2. 05	64. 81	1. 072	1. 52	13. 02	3. 37	Light green.
20	16	3134	1	11. 5	1. 1	2. 19	2. 05	65. 88	1. 071	2. 86	11. 92	3. 89	
22	16	3169	1	10. 3	1. 1	2. 09	1. 76	67. 96	1. 067	Lost.	Lost.	Lost.	Light cinnamon.
25	17	3224	1	10. 1	1. 0	1. 14?	1. 57	64. 04	1. 080	2. 95	12. 81	3. 44	Light green.
27	16	3280	1	10. 5	1. 1	1. 43	1. 29	67. 01	1. 070	3. 97	6. 44?	7. 16?	Do.
29	17	3322	1	11. 7	1. 2	2. 06	1. 82	60. 41	1. 077	1. 92	13. 11	3. 68	Do.
30	18	3349	1	11. 0	1. 2	2. 50	2. 22	69. 31	1. 067	1. 82	11. 63	3. 19	Very light green.
Nov. 4	18	3403	1	11. 0	1. 4	2. 10	2. 00	65. 27	1. 069	2. 58	11. 85	1. 87	Brown.
5	18	3434	1	11. 0	1. 1	1. 89	1. 74	67. 22	1. 065	2. 73	11. 67	2. 74	Light green.
10	18†	3491	1	6. 0	1. 2	1. 53	1. 52	72. 25	1. 060	2. 69	9. 71	3. 14	Do.
12	18	3512	1	11. 3	1. 1	1. 82	1. 73	66. 88	1. 066	1. 58	11. 08	. 75?	Do.

*Topped August 28. †Topped.

TABLE No. 34.—HONDURAS. E. LINK, GREENEVILLE, TENN.

Aug. 11	F.	674	1	9. 5	1. 3	3. 45	2. 61	69. 42	1. 033	4. 40	3. 06	1. 40	Dark green, watery.
11	F.	675	1	7. 5	1. 4	2. 97	2. 59	64. 27	1. 032	4. 43	2. 31	1. 69	Do.
11	F.	676	1	8. 4	1. 3	2. 97	2. 35	66. 77	1. 032	4. 88	1. 81	1. 79	Do.
11	F.	677	1	8 6	1. 0	1. 95	1. 52	68. 06	1. 035	4. 89	2. 63	1. 56	Do.
18	1	929	1	11. 0	1. 2	2. 75	2. 25	62. 75	1. 031	4. 23	2. 48	1. 30	Do.
18	1	930	2	8. 9	1. 0	5. 34	4. 29	66. 90	1. 039	3. 97	4. 14	2. 04	Do.
18	1	931	1	10. 6	1. 2	2. 78	2. 26	70. 05	1. 034	4. 34	2. 54	1. 87	Do.
18	1	932	1	10. 0	1. 0	2. 06	1. 61	70. 98	1. 036	4. 91	3. 05	1. 31	Do.
23	2	1101	1	8. 9	1. 0	2. 02	1. 49	67. 97	1. 051	3. 76	7. 14	2. 09	Dark green, some starch.
23	2	1102	1	10. 8	1. 0	2. 61	2. 10	65. 65	1. 042	4. 71	4. 48	1. 80	Do.
23	2	1103	1	11. 3	1. 2	2. 95	2. 42	68. 65	1. 039	4. 61	4. 26	1. 67	Do.
23	2	1104	1	11. 5	1. 0	2. 36	1. 90	69. 94	1. 036	4. 62	4. 66	. 32	Do.
25	3	1225	1	12. 4	1. 1	2. 77	2. 21	60. 56	1. 037	4. 71	3. 77	1. 45	Dark green, starchy.
25	3	1226	1	11. 2	. 9	2. 07	1. 64	60. 48	1. 040	4. 80	4. 19	1. 44	Do.
25	3	1227	1	11. 0	. 9	1. 91	1. 52	60. 71	1. 036	5. 19	3. 09	1. 61	Do.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Aug. 25	3	1228	1	11.3	1.1	2.18	1.72	70.26	1.035	4.40	3.33	1.50	Dark green, starchy.
28	4	1369	1	12.8	1.2	3.30	2.68	69.26	1.041	4.38	5.14	1.38	Dark green, watery.
28	4	1370	1	12.1	1.4	4.92	4.05	63.63	1.041	4.79	4.19	1.68	Do.
28	4	1371	1	13.1	1.2	3.70	2.16	67.87	1.045	4.32	5.26	2.00	Dark green, starchy.
28	4	1372	1	11.4	1.0	1.97	1.59	68.56	1.042	5.23	4.21	1.64	Dark green, watery.
Sept. 2	5	1577	1	12.0	.8	1.85	1.48	70.77	1.037	5.05	3.33	1.31	Dark brown, some starch.
2	5	1578	1	12.5	1.0	2.57	2.08	70.37	1.048	4.95	5.43	1.73	Do.
2	5	1579	1	12.3	1.0	2.26	1.74	72.53	1.043	4.95	4.31	1.62	Do.
2	5	1580	1	11.3	.7	1.52	1.21	65,87	1.046	5.05	5.19	1.43	Do.
6	6	1737	1	13.4	1.2	2.83	2.24	59.72	1.051	4.28	7.14	1.81	Dark green, some starch.
6	6	1738	1	12.4	1.2	2.77	2.33	60.26	1.056	4.18	7.95	1.80	Do.
6	6	1739	1	12.2	1.3	3.01	2.53	67,04	1.053	4.19	7.77	1.43	Do.
6	6	1740	1	11.3	1.0	1.74	1.40	66.61	1.056	1.63	10.00	2.67	Do.
14	8	1977	1	12.0	1.2	2.63	2.23	69.66	1.057	4.03	6.89	3.22	Light green, some starch.
14	8	1978	1	12.3	1.4	3.00	2.50	66.22	1.054	3.97	7.29	2.13	Do.
14	8	1979	1	12.6	1.3	3.03	2.54	71.08	1.053	4.57	6.74	1.60	Do.
14	8	1980	1	12.0	1.0	1.71	1.45	72.60	1.050	4.56	6.19	1.54	Do.
21	9	2233	1	12.0	1.2	1.51?	2.25	66.21	1.060	3.42	9.52	2.16	Thin, watery.
21	9	2234	1	10.6	1.2	3.28	Lost.	Lost.	1.066	2.57	10.93	2.82	Dark green, starchy.
21	9	2235	1	10,2	1.2	1.73	Lost.	Lost.	1.052	4.30	6.75	2.26	Thin, watery.
21	9	2236	1	11.5	1.0	1.78	1.43	62.96	1.055	4.30	7.89	1.69	Do.
23	10	2340	1	12.7	1.2	2.90	2.43	58.13	1.060	3.47	9.92	1.51	Dark green, some starch.
23	10	2347	1	12.8	1.1	2.52	2.09	68.87	1.057	3.96	8.54	1.78	Do.
23	10	2348	1	12.2	1.2	2.64	2.22	67.73	1.062	3.13	10.17	2.29	Do.
23	10	2349	1	12.7	1.3	2.95	2.65	67.44	1.052	3.30	7.68	2.04	Do,
25	11	2486	1	13.5	1.2	3.32	2.88	67.59	1.057	3.07	9.50	2.19	Do.
25	11	2487	1	13.2	1.2	3.78	3.16	67.52	1.060	2.90	8.76	3.77	Do.
25	11	2488	1	12.1	1.2	3.52	2.94	67.26	1,058	2.80	9.35	2.07	Do.
25	11	2489	1	12.0	1.0	2.33	1.94	65.90	1.060	2.98	9.85	2.46	Do.
Oct. 1	11*	2706	1	8.5	1.1	2.41	2.13	66.45	1.069	3.33	11.26	2.22	Green.
5	12	2759	1	12.3	1.3	3.52	2.85	66.51	1.067	1.69	12.53	2.51	Very light green, starchy.
7	12	2824	1	13.0	1.3	4.28	3.48	68.39	1.069	1.73	12.46	2.84	Green.
12	12	2939	1	10.0	1.0	1.86	1.52	58.24	1.072	1.71	13.02	3.21	Light green, starchy.
14	12	2986	1	10.1	1.0	2.15	1.74	67.08	1.076	2.07	13.29	3.24	Dark green.
15	13	3017	1	13.5	1.3	2.84	2.51	66.02	1.068	2.47	8.77?	6.55?	Light green.
16	13	3054	1	12.8	1.2	2.76	2.44	61.26	1.072	1.67	13.04	3.63	Very dark green.
19	13	3111	1	11.4	1.3	2.02	1.88	68.42	1.062	2.86	10.31	2.84	Light green.
21	13	3143	1	11.4	1.0	1.87	1.65	64.40	1.073	2.27	12.37	3.53	Do.
22	13	3174	1	13.3	1.3	2.79	2.39	67.92	1.068	2.46	10.59	4.08	Dark green.
26	14	3238	1	13.0	1.3	2.71	2.56	64.03	1.074	2.71	13.63	2.14	Light green.
28	14	3296	1	11.5	1.0	1.43	1.30	62.84	1.074	3.23	12.24	3.01	Green.
29	14	3327	1	11.5	1.1	1.61	1.44	63.05	1.073	2.68	12.00	3.36	Deep brown.
Nov. 2	14	3372	1	12.5	1.1	.....	1.90	66.94	1.073	4.90	10.06	2.89	Olive green.
4	15	3407	1	11.5	1.1	1.77	1.63	57.95	1.077	4.53	10.78	3.22	Dark straw.
4	15	3417	1	12.3	1.4	2.17	2.13	64.94	1.074	4.07	11.17	3.63	Light olive.
13	16	3516	1	11.0	1.0	1.40	1.34	67.87	1.065	3.65	10.31	2.00	Light green.

* Topped August 28.

TABLE No. 35.—HONEY TOP OR TEXAS CANE. BRUSSELS, MO.

Aug. 6	1	517	1	8.0	1.1	2.15	1.72	68.72	1.033	5.07	1.28	2.31	Thin, watery.
9	1	579	1	8.5	1.1	2.82	2.18	68.38	1.037	4.38	3.13	1.68	Watery, some starch.
13	2	768	1	9.8	1.1	2.63	2.05	70.92	1.038	4.54	3.16	1.93	Very dark green.
11	1	658	1	10.5	1.3	3.34	2.55	70.87	1.029	4.45	1.68	1.60	Dark green, watery.
11	1	659	1	9.1	1.0	1.98	1.52	70.00	1.030	4.99	2.18	1.64	Do.
11	1	660	1	9.7	1.1	2.20	1.76	71.69	1.032	4.84	1.73	1.81	Do.
11	1	661	1	9.2	1.1	2.45	1.96	69.74	1.033	4.90	2.15	1.62	Do.
14	2	787	1	11.1	1.1	2.73	2.20	71.03	1.033	4.66	2.45	1.51	Dark green.
14	2	788	1	10.4	1.1	2.51	1.98	72.20	1.036	4.86	2.47	1.98	Do.
14	2	789	1	10.8	1.3	2.50	1.98	71.33	1.032	4.84	1.76	1.64	Dark green, watery.
14	2	790	1	10.4	1.2	3.17	2.45	60.78	1.033	4.80	2.22	1.74	Do.
17	2	891	1	11.3	1.3	3.30	2.70	69.09	1.037	Lost.	Lost.	Lost.	Dark green, starchy.
17	2	892	1	11.1	1.0	2.18	1.77	71.34	1.038	4.91	3.27	1.60	Do.
17	2	893	1	11.5	1.4	2.68	2.54	71.34	1.036	4.92	2.78	1.57	Do.
17	2	894	1	10.9	1.2	2.68	2.23	69.96	1.037	Lost.	Lost.	Lost.	Do.
18	2	917	1	11.0	1.0	2.32	1.95	70.74	1.035	4.79	2.40	1.90	Do.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Aug. 18	2	918	1	11.4	1.2	2.23	1.92	71.24	1.037	4.63	2.79	1.89	Dark green, starchy.
18	2	919	1	11.4	1.2	3.01	2.49	70.76	1.035	4.62	2.58	1.83	Do.
18	2	920	1	11.0	1.2	3.02	2.46	72.05	1.038	4.57	3.45	1.81	Do.
21	3	1072	1	11.5	1.0	2.26	1.82	72.42	1.037	4.67	3.51	1.32	Thin, watery.
21	3	1073	1	11.5	1.0	2.17	1.77	70.40	1.039	4.72	3.86	1.33	Do.
21	3	1074	1	12.0	1.3	3.14	2.59	69.28	1.036	4.59	3.38	1.46	Do.
21	3	1075	1	10.6	1.0	2.04	1.69	70.09	1.039	4.97	3.69	1.25	Do.
25	4	1205	1	12.1	1.1	2.39	1.93	71.66	1.037	4.95	3.42	1.22	Dark green, starchy.
25	4	1206	1	12.2	1.1	2.22	1.78	71.04	1.041	4.68	4.61	1.28	Do.
25	4	1207	1	12.6	1.1	2.54	2.03	72.13	1.040	4.75	4.40	1.38	Do.
25	4	1208	1	12.4	1.2	2.85	2.32	69.61	1.042	4.86	4.73	1.29	Do.
28	5	1349	1	11.2	.8	1.51	1.17	70.09	1.046	4.88	5.22	1.85	Dark green, watery.
28	5	1350	1	11.2	.9	1.73	1.38	71.36	1.040	4.04	4.54	2.05	Do.
28	5	1351	1	12.6	1.0	2.35	1.92	73.05	1.038	5.03	3.57	1.71	Do.
28	5	1352	1	12.5	1.1	2.44	2.01	69.95	1.037	4.81	4.57	.50	Do.
30	6	1391	1	12.7	1.0	2.44	2.02	68.52	1.050	4.84	5.91	2.20	Dark green, some starch.
30	6	1392	1	12.6	1.1	2.57	2.12	69.12	1.051	4.80	6.35	1.84	Do.
30	6	1393	1	12.5	1.0	2.42	1.99	69.78	1.050	4.88	6.45	1.86	Do.
30	6	1394	1	12.4	1.0	2.34	1.91	68.39	1.048	4.68	5.98	2.08	Do.
30	7	1399	1	12.6	1.1	2.70	2.13	69.28	1.043	4.35	5.39	1.67	Do.
30	7	1400	1	12.0	1.0	2.06	1.63	69.59	1.051	3.57	7.61	2.12	Do.
30	7	1401	1	12.8	1.2	2.67	2.18	69.34	1.047	4.32	5.99	2.01	Do.
30	7	1402	1	12.4	1.0	2.30	1.79	70.55	1.054	4.36	7.57	2.07	Do.
30	8	1407	1	12.7	1.1	2.48	2.01	72.81	1.046	4.58	5.54	1.78	Do.
30	8	1408	1	13.0	1.2	3.35	2.68	68.85	1.050	4.39	6.16	1.45	Do.
30	8	1409	1	12.0	1.1	2.86	2.41	68.77	1.050	4.15	6.82	2.79	Do.
30	8	1410	1	12.4	1.2	3.13	2.46	71.88	1.052	3.98	7.39	2.27	Do.
30	9	1415	1	12.3	1.2	2.84	2.31	70.60	1.053	4.11	7.83	1.93	Do.
30	9	1416	1	12.1	1.1	2.55	2.04	69.74	1.054	4.33	7.27	2.49	Do.
30	9	1417	1	11.5	1.1	2.88	2.29	69.76	1.053	4.51	7.31	1.95	Do.
30	9	1418	1	12.9	1.1	2.86	2.22	68.81	1.055	4.11	8.33	1.92	Do.
Sept. 2	9	1557	1	12.8	1.1	2.61	1.93	70.50	1.047	4.52	6.01	1.12	Do.
2	9	1558	1	11.0	1.3	2.66	2.11	69.17	1.042	4.33	4.91	1.17	Do.
2	9	1559	1	11.0	1.2	2.88	2.39	67.56	1.054	3.95	7.69	1.64	Do.
2	9	1560	1	11.6	1.3	3.26	2.66	69.92	1.054	3.66	7.92	1.75	Do.
6	10	1709	1	12.0	1.2	3.04	2.41	71.23	1.053	3.86	7.95	1.82	Dark green, starchy.
6	10	1710	1	11.2	1.3	3.06	2.36	70.11	1.048	4.10	6.55	1.80	Do.
6	10	1711	1	12.3	1.3	3.01	2.33	70.10	1.049	4.16	6.63	1.98	Do.
6	10	1712	1	11.7	1.2	2.64	2.08	71.00	2.046	4.22	5.78	1.90	Do.
14	11	1957	1	11.3	1.0	1.90?	2.54	69.95	1.059	3.37	9.49	1.49	Light green, some starch.
14	11	1958	1	11.7	1.3	2.55	2.09	72.00	1.055	3.70	7.29	2.37	Do.
14	11	1959	1	11.6	1.3	2.86	2.34	70.95	1.051	4.09	5.86	2.46	Do.
14	11	1960	1	10.5	1.2	2.03	1.59	70.64	1.049	5.52	3.81	2.44	Do.
17	11	2098	1	11.2	1.2	2.11	1.76	85.12?	1.047	4.00	5.18	2.62	Dark green, starchy.
17	11	2099	1	11.4	1.3	3.11	2.60	69.74	1.046	4.30	5.00	2.32	Do.
17	11	2100	1	11.9	1.2	2.42	2.32	59.49	1.061	3.59	8.90	2.73	Do.
17	11	2101	1	11.3	1.2	2.50	2.07	65.85	1.060	3.71	8.68	2.66	Do.
21	12	2213	1	12.2	1.2	2.55	2.12	68.98	1.054	4.07	7.42	1.84	Thin, watery.
21	12	2214	1	14.1	1.4	3.43	2.84	69.00	1.050	4.06	7.27	1.38	Do.
21	12	2215	1	11.6	1.2	2.63	2.30	68.07	1.052	4.33	6.75	1.94	Do.
21	12	2216	1	11.4	1.2	2.41	1.96	67.07	1.060	3.37	9.12	2.42	Do.
23	13	2322	1	12.1	1.2	2.09	1.78	64.80	1.054	3.94	7.30	1.99	Dark green, watery.
23	13	2323	1	12.7	1.2	2.52	2.16	64.28	1.067	2.44	11.38	2.58	Do.
23	13	2324	1	12.7	1.1	2.51	2.12	65.48	1.062	3.59	9.74	1.92	Do.
23	13	2325	1	12.0	1.1	2.75	2.28	61.35	1.067	2.13	11.41	3.10	Do.
25	13	2466	1	10.0	1.0	2.00	1.71	69.23	1.051	4.28	6.28	2.38	Dark green, some starch.
25	13	2467	1	13.4	1.2	3.41	3.03	68.07	1.060	3.09	9.77	2.38	Do.
25	13	2468	1	11.6	1.2	2.69	2.29	62.89	1.068	2.76	11.81	2.52	Do.
25	13	2469	1	12.4	1.2	2.29	1.94	63.50	1.064	3.05	10.00	3.16	Do.
28	14	2626	1	13.0	1.1	2.42	2.04	67.45	1.059	3.41	9.12	2.11	Do.
28	14	2627	1	10.6	1.3	3.19	2.57	65.72	1.062	3.05	10.34	2.05	Do.
28	14	2628	1	11.5	1.1	2.52	2.16	66.22	1.064	2.69	9.94	3.12	Do.
28	14	2629	1	12.6	1.2	2.55	2.16	62.85	1.069	2.51	11.59	2.66	Do.
Oct. 1	*15	2700	1	10.3	1.3	2.64	2.22	62.17	1.071	2.53	12.21	2.97	Green, turbid.
4	15	2750	1	12.9	1.1	2.99	2.49	66.61	1.064	3.27	10.53	2.46	Very light green.
7	15	2818	1	13.0	1.1	2.40	2.51	69.96	1.061	3.62	9.12	2.44	Green.
12	15	2933	1	11.6	1.1	2.90	2.44	69.10	1.068	2.81	11.79	2.39	Light green, starchy.
13	†15	2980	1	12.4	1.1	2.22	1.93	63.12	1.072	2.33	12.45	3.11	Do.

* Topped August 28. † Topped.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Oct. 15	16	3012	1	11.2	1.1	2.60	2.20	65.80	1.074	1.91	13.45	4.24	Light green, starchy.
16	16	3049	1	12.1	1.0	1.63	1.51	60.58	1.071	2.16	12.20	3.68	Dark green.
19	17	3106	1	9.3	1.0	2.38	1.99	64.64	1.076	1.28	13.96	4.37	Light green.
20	17	3133	1	11.4	1.1	2.70	2.48	63.51	1.075	1.95	13.72	3.69	
22	*16	3168	1	9.0	1.1	2.05	1.83	65.30	1.074	1.80	12.66	4.29	Light green.
25	17	3223	1	12.1	1.2	2.13	1.98	66.30	1.078	2.67	12.78	3.99	Do.
27	*18	3279	1	6.0	1.2	1.25	1.20	66.67	1.058	4.43	7.91	2.12	Do.
29	17	3321	1	11.3	1.1	1.86	1.67	67.37	1.076	3.15	12.24	3.01	Do.
30	18	3348	1	12.4	1.2	2.46	2.27	69.38	1.057	4.11	8.36	2.05	Very light green
Nov. 3	18	3397	1	12.1	1.2	1.92	1.85	70.95	1.054	4.22	6.42	2.93	Light green.
5	18	3433	1	12.5	1.8	2.07	1.96	70.45	1.065	2.51	12.00	1.92	Do.
10	*18	3490	1	5.5	1.1	1.20	1.11	72.76	1.060	2.38	9.72	3.30	Do.
12	18	3511	1	11.8	1.2	1.95	1.88	68.77	1.068	2.65	10.74	2.95	Do.

* Topped.

TABLE NO. 36.—HONDURAS. L. BRANDE, MAYERSVILLE, TEX.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
Aug. 2	1	364	1	8.3	1.3	3.37	2.68	66.64	1.031	2.73	3.75	1.87	Light green, starchy.
10	2	595	1	10.3	1.3	3.06	2.45	70.77	1.032	5.05	1.94	1.29	Dark green, watery.
9	3	583	1	9.4	1.3	2.66	2.07	66.88	1.036	4.65	3.72	1.14	Thin, watery.
11	F	666	1	9.5	1.0	2.34	1.78	71.00	1.032	4.87	2.55	1.16	Dark green, watery.
11	F	667	1	9.0	1.1	2.40	1.62	69.93	1.037	5.32	3.74	.88	Do.
11	F	668	1	8.6	1.1	2.36	1.88	67.53	1.035	5.02	2.98	1.23	Do.
11	F	669	1	8.1	1.0	2.43	1.85	67.94	1.032	4.84	2.16	1.53	Do.
14	1	803	1	10.6	1.2	2.97	2.27	60.55	1.033	4.59	1.70	2.13	Do.
14	1	804	1	9.0	1.1	2.01	1.57	68.39	1.037	5.42	2.70	1.33	Do.
14	1	805	1	10.0	1.0	2.28	1.77	70.89	1.035	4.98	2.52	1.53	Do.
14	1	806	1	10.0	1.1	2.72	1.92	74.80	1.036	5.31	2.64	1.22	Do.
18	2	921	1	11.3	1.1	3.35	2.73	71.02	1.036	4.60	3.26	1.60	Do.
18	2	932	1	10.5	1.1	2.68	2.23	69.35	1.039	4.90	3.32	1.74	Do.
18	2	923	1	11.0	1.2	3.08	2.49	70.69	1.039	4.82	3.08	2.11	Do.
18	2	924	1	10.8	1.0	2.96	2.37	69.16	1.041	4.84	3.84	1.84	Do.
23	3	1093	1	12.5	1.1	2.97	2.47	70.45	1.038	4.31	4.16	1.26	Do.
23	3	1094	1	11.9	1.1	2.56	2.09	70.36	1.035	4.57	3.45	1.30	Do.
23	3	1095	1	11.6	1.1	2.98	2.47	66.07	1.041	4.85	3.95	1.72	Do.
23	3	1096	1	11.7	1.1	2.89	2.82	58.20	1.039	4.39	4.34	1.52	Do.
25	4	1217	1	12.5	1.0	2.53	2.02	70.54	1.044	4.66	5.02	1.81	Do.
25	4	1218	1	12.0	1.0	2.27	1.75	70.14	1.041	5.40	3.70	1.61	Do.
25	4	1219	1	13.1	1.2	3.28	2.63	71.26	1.039	4.61	3.90	1.69	Do.
25	4	1220	1	12.6	.9	2.16	1.72	71.42	1.038	4.80	3.97	1.34	Do.
28	5	1357	1	12.6	1.0	2.09	1.68	69.67	1.044	4.92	5.04	1.68	Do.
28	5	1358	1	11.9	1.0	2.04	1.63	68.64	1.047	5.16	5.53	1.54	Do.
28	5	1359	1	11.9	1.2	2.80	2.27	67.50	1.046	5.19	5.40	2.46	Do.
28	5	1360	1	13.1	1.1	2.93	2.38	67.11	1.046	4.86	5.82	1.41	Do.
Sept. 2	6	1569	1	12.8	1.1	2.83	2.57	61.88	1.046	4.47	5.47	1.63	Dark brown, some starch.
2	6	1570	1	12.7	1.0	2.34	2.00	61.00	1.043	5.15	4.14	1.40	Do.
2	6	1571	1	12.0	1.0	2.06	1.71	69.55	1.047	4.88	5.65	1.36	Do.
2	6	1572	1	11.9	1.0	2.07	1.68	67.23	1.050	4.67	5.86	1.80	Do.
6	7	1725	1	13.5	1.2	2.85	2.38	69.59	1.047	4.08	6.33	1.82	Dark green, some starch.
6	7	1726	1	11.5	1.1	2.21	1.82	66.94	1.056	4.53	7.54	2.13	Do.
6	7	1727	1	12.6	1.2	2.53	2.05	66.73	1.057	3.81	8.45	2.07	Do.
6	7	1728	1	12.7	1.1	2.53	2.19	69.50	1.050	4.56	6.64	1.80	Do.
6	8	1729	1	12.5	1.2	2.20	1.91	67.70	1.053	4.04	7.74	1.47	Do.
6	8	1730	1	10.6	1.2	2.23	1.75	55.94	1.058	3.58	7.78	3.57	Do.
6	8	1731	1	12.5	1.2	2.50	2.12	69.60	1.055	4.33	7.02	2.38	Do.
6	8	1732	1	13.2	1.2	2.60	2.17	70.55	1.050	4.38	7.03	1.59	Do.
6	9	1733	1	12.1	1.3	2.97	2.49	69.91	1.047	4.00	6.63	1.55	Do.
6	9	1734	1	11.1	1.2	2.58	2.11	66.49	1.058	3.67	8.70	1.07	Do.
6	9	1735	1	12.9	1.2	2.85	2.60	62.37	1.058	3.69	8.55	2.46	Do.
6	9	1736	1	12.5	1.1	2.72	2.22	67.23	1.052	4.18	7.60	1.58	Do.
14	8	1973	1	13.5	1.2	2.88	2.38	67.83	1.055	3.64	7.80	1.87	Light green, some starch.
14	8	1974	1	10.0	1.1	1.71	1.54	68.71	1.057	4.49	7.58	1.98	Do.
14	8	1975	1	11.6	1.1	2.05	1.65	70.76	1.055	4.44	6.02	2.90	Do.
14	8	1976	1	12.6	1.1	2.33	2.00	67.55	1.060	3.83	7.11	3.92	Do.
21	9	2225	1	12.7	1.1	2.13	1.83	67.02	1.056	3.49	8.92	2.50	Thin, watery.
21	9	2226	1	12.6	1.1	2.05	1.66	68.03	1.062	3.88	10.17	1.49	Do.
21	9	2227	1	13.1	1.1	2.64	2.14	66.01	1.050	3.81	7.35	1.50	Do.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Sept. 21	9	2228	1	12.6	1.2	2.33	1.98	65.85	1.056	3.55	8.77	1.64	Thin, watery.
23	10	2338	1	13.1	1.0	2.29	1.94	65.41	1.056	3.54	9.30	1.60	Dark green, some starch.
23	10	2339	1	12.9	1.2	2.94	2.41	62.59	1.058	3.19	9.20	2.21	Do.
23	10	2340	1	12.0	1.2	3.04	2.52	67.59	1.053	3.22	8.67	1.26	Do.
23	10	2341	1	12.2	1.2	2.49	2.15	65.12	1.052	3.03	8.41	1.29	Do.
25	11	2478	1	13.2	1.2	3.30	2.79	61.72	1.055	3.18	9.03	7.27?	Do.
25	11	2479	1	12.3	1.2	3.09	2.73	66.50	1.061	3.20	9.98	6.71?	Do.
25	11	2480	1	13.3	1.2	3.08	2.61	69.94	1.060	3.01	9.98	2.30	Do.
25	11	2481	1	12.6	1.1	2.20	1.78	63.86	1.064	2.76	10.79	2.71	Do.
28	12	2642	1	13.0	1.0	2.79	2.16	65.74	1.060	2.31	10.53	2.02	Do.
28	12	2643	1	13.0	1.2	......	2.00	66.25	1.049	3.75	6.62	1.83	Do.
28	12	2644	1	10.5	1.2	2.81	2.27	66.79	1.059	2.84	9.48	2.27	Do.
28	12	2645	1	13.3	1.2	3.25	2.70	66.19	1.050	3.61	7.23	1.54	Do.
Oct 1	*14	2704	1	9.3	1.2	2.47	1.98	73.94	1.072	1.61	13.05	2.95	Green.
5	13	2757	1	12.7	1.2	3.26	2.51	71.22	1.061	2.69	11.03	1.97	Very light green.
7	13	2822	1	12.4	1.2	2.86	2.37	72.72	1.059	4.11	8.16	6.20?	Green.
12	13	2937	1	12.0	1.1	2.51	2.11	65.31	1.070	1.43	12.92	4.32	Light green, starchy.
14	13	2984	1	10.4	1.1	3.08	2.59	61.71	1.067	2.00	11.45	3.00	Do.
15	14	3015	1	13.0	1.3	3.27	2.70	66.77	1.068	1.69	11.54	4.28	Dark straw.
16	14	3052	1	12.8	1.1	2.77	2.35	70.19	1.066	3.34	10.57	3.26	Dark green.
19	15	3109	1	12.8	1.1	2.51	2.31	67.59	1.070	1.93	12.54	3.20	Light green.
20	15	3136	1	11.6	1.0	2.33	2.07	52.87	1.074	2.09	5.75?	11.76?	
22	13	3172	1	13.0	1.1	1.87	1.63	66.17	1.063	3.70	11.00	1.48	Dark green.
26	15	3236	1	13.6	1.2	2.16	2.10	63.94	1.071	1.90	12.32	3.44	Light green.
28	†15	3294	1	9.4	1.1	1.83	1.73	63.44	1.071	2.63	12.31	2.99	Dark green.
29	15	3325	1	11.6	1.0	1.78	1.54	66.57	1.073	3.39	11.01	2.10	Brown.
Nov. 2	16	3370	1	11.0	1.0	......	1.67	74.18	1.068	1.81	12.26	Lost	Light green.
4	16	3405	1	11.5	1.4	1.86	1.76	68.63	1.065	4.14	9.00	2.18	Yellowish green.
5	16	3436	1	12.8	1.3	2.78	2.63	64.10	1.066	3.14	11.50	Lost	Light olive.
10	16	3493	1	10.3	1.1	2.34	2.27	68.51	1.069	2.42	11.83	3.38	Light green.
12	16	3514	1	12.0	1.0	1.66	1.57	63.08	1.066	2.70	10.14	3.10	Do.

*Topped August 28. †Topped.

TABLE No. 37.—SUGAR CANE. C. E. MILLER, EFFINGHAM, ILL.

July 13	1	7	2	5.5	0.9	......	1.28	53.30	1.029	3.94	1.71	1.09	
16	2	18	2	5.7	.6	1.54	1.10	44.37	1.031	4.36	2.30	1.05	
17	3	27	2	6.6	.8	2.59	1.90	51.61	1.030	3.92	2.35	1.87	
17	4	28	2	6.0	.7	1.72	1.22	47.60	1.035	4.41	3.18	1.58	
20	5	60	2	5.5	.7	1.90	1.31	54.99	1.046	3.73	5.97	1.96	
21	6	84	1	8.0	.8	1.59	1.16	56.25	1.043	3.23	5.24	2.46	
22	7	103	2	6.3	.7	2.35	1.39	59.34	1.055	3.46	2.85?	7.58?	
24	7	148	1	8.1	.7	1.82	1.34	53.18	1.048	3.29	6.96	1.77	
23	8	130	1	8.2	.7	1.45	1.09	63.29	1.048	4.12	5.94	2.35	
26	9	177	1	8.5	.7	1.44	1.18	63.20	1.054	3.41	8.64	1.56	Light green, starchy.
27	9	227	1	6.0	.7	1.20	.79	44.78	1.057	3.61	8.19	3.15	Do.
29	9	256	2	5.8	.7	2.25	1.43	64.05	1.051	2.75	7.36	2.64	Dark green.
30	10	289	2	5.7	.7	2.16	1.35	61.02	1.063	2.68	10.25	2.59	Lighter gr'n, starchy.
31	10	337	1	5.5	.6	.94	.61	63.54	1.059	2.84	8.85	3.37	Do.
Aug. 2	10	361	1	5.6	.8	1.01	.65	61.72	1.054	2.96	8.28	2.56	Light green, starchy.
4	10	432	1	5.3	.9	1.25	.74	65.97	1.050	2.38	7.98	1.97	Do.
6	10	515	1	5.7	.9	1.04	.66	64.67	1.054	2.38	8.67	2.42	Dark green, starchy.
7	11	543	1	5.5	.8	1.09	.61	Lost.	1.054	2.67	8.62	2.37	Do.
9	11	577	1	6.7	.7	1.28	.83	65.33	1.058	2.52	10.00	1.61	Watery, starchy.
5	10	473	1	6.0	1.0	1.29	.82	64.79	1.052	2.68	7.22	2.89	Dark green, starchy.
5	10	474	1	6.0	.7	1.01	.64	66.55	1.043	2.77	5.32	2.60	Do.
5	10	475	1	6.5	.9	1.14	.77	66.19	1.051	2.70	7.49	2.61	Do.
5	10	476	1	6.0	.9	.93	.81	45.92	1.063	2.60	9.71	3.17	Do.
13	12	752	1	5.9	.8	1.03	.68	63.19	1.053	1.72	8.67	2.86	Do.
13	12	753	1	6.8	.6	.97	.54	65.10	1.049	2.22	7.45	2.44	Do.
13	12	754	1	7.0	.7	1.11	.82	60.43	1.060	2.43	10.06	2.37	Do.
13	12	755	1	6.0	.9	1.19	.82	66.76	1.050	2.13	7.31	2.80	Do.
17	13	883	1	6.1	.7	1.02	.64	68.62	1.032	2.70	2.86	4.39	Do.
17	13	884	1	6.4	.8	1.13	.75	65.16	1.060	1.09	9.79	3.84	Do.
17	13	885	1	5.4	.6	.92	.52	65.13	1.032	2.74	Lost.	Lost.	Do.
17	13	886	1	5.7	.7	.92	.58	64.88	1.032	3.46	1.29	2.95	Do.
18	13	909	1	8.0	.8	1.51	1.14	62.30	1.074	1.78	13.31	4.51	Do.
18	13	910	1	6.8	.7	1.01	.66	68.05	1.061	1.76	9.80	3.14	Do.
18	13	911	1	6.6	.7	1.14	.83	67.39	1.058	2.42	9.28	2.51	Do.

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Aug. 18	13	912	1	5.6	0.7	.98	.57	66.02	1.038	3.17	3.62	2.60	Dark green, starchy.
21	14	1064	1	5.0	.8	1.00	.60	65.80	1.032	2.36	3.34	2.34	Do.
21	14	1065	1	5.6	.7	.97	.57	66.98	1.034	2.85	3.39	2.17	Thin, watery.
21	14	1066	1	5.6	.8	.91	.57	67.44	1.032	3.43	2.27	2.29	Do.
21	14	1067	1	6.0	.7	.91	.59	67.97	1.045	3.58	5.12	2.50	Thin, some starch.
25	15	1197	1	5.8	1.0	1.26	.82	63 30	1.063	2.08	11.85	1.92	Dark green, starchy.
25	15	1198	1	5.9	.8	.87	.53	67.28	1.039	3.79	4.17	2.00	Do.
25	15	1199	1	6.1	.7	.93	.56	70.39	1.040	3.93	3.99	2.18	Do.
25	15	1200	1	6.1	.7	.83	.56	65.09	1.058	3.07	8.75	2.78	Do.
27	16	1327	1	5.6	.8	1.32	.67	65.90	1.037	3.60	3.31	2.44	Do.
27	16	1328	1	6.5	.9	1.11	.86	68.84	1.054	2.73	7.75	2.90	Do.
27	16	1329	1	6.0	.7	.91	.61	66.85	1.050	3.20	6.40	2.64	Do.
27	16	1330	1	6.1	.7	.98	.64	63.67	1.361	2.27	9.64	3.31	Do.
Sept. 2	16	1549	2	5.5	.8	2.08	1.45	67.98	1.051	3.13	6.81	2.57	Dark green, some starch.
2	16	1550	2	6.0	.5	1.63	1.05	65.05	1.047	3.92	4.94	2.55	Do.
2	16	1551	2	5.3	.6	1.71	1.14	64.67	1.048	2.72	6.66	2.21	Do.
2	16	1552	2	6.0	.6	1.70	.97	67.27	1.061	2.39	10.38	2.03	Do.
6	16	1701	2	6.3	.6	1.81	1.13	60.38	1.065	1.78	11.95	2.42	Dark green, starchy.
6	16	1702	2	5.7	.6	1.47	.87	64.64	1.062	2.47	10.82	2.06	Do.
6	16	1703	2	5.7	.7	1.69	.99	60.89	1.050	3.13	7.11	2.24	Do.
6	16	1704	2	6.0	.7	1.74	1.14	67.69	1.044	2.87	6.25	1.94	Do.
10	16	1901	1	5.9	.8	.98	.61	60.86	1.027	3.42	7.96	1.66	Do.
10	16	1902	1	5.6	.8	1.18	.79	63.69	1.057	2.41	8.85	1.79	Do.
10	16	1903	1	6.0	.8	.95	.61	63.66	1.053	3.60	6.96	1.64	Do.
10	16	1904	1	6.0	.7	.84	.55	62.00	1.047	4.23	5.08	2.00	Do.
17	16	2090	1	8.4	.9	1.48	1.09	67.63	1.050	2.53	7.48	2.75	Do.
17	16	2091	2	5.7	.8	2.09	1.32	62.66	1.054	3.18	8.02	2.37	Do.
17	16	2092	1	8.3	.9	1.63	1.05	67.36	1.058	3.45	8.51	2.55	Do.
17	16	2093	2	8.0	.8	2.00	1.34	63.50	1.066	2.86	11.17	2.72	Do.
21	16	2205	1	8.0	.9	1.40	1.12	65.08	1.049	3.59	6.86	1.75	Do.
21	16	2206	1	8.1	.8	1.30	.95	62.32	1.056	3.03	8.84	2.19	Do.
21	16	2207	1	7.8	.8	1.63	1.17	64.02	1.059	2.87	9.70	2.11	Thin, watery.
21	16	2208	1	8.8	.9	1.93	1.29	65.92	1.067	2.43	12.01	2.05	Do.
25	17	2458	2	6.3	.8	2.20	1.61	60.91	1.059	2.36	9.64	2.87	Dark green, starchy.
25	17	2459	2	5.9	.8	2.00	1.38	63.15	1.058	2.36	9.88	3.78	Do.
25	17	2460	2	7.5	.8	2.30	1.49	64.30	1.055	2.84	8.22	2.83	Do.
25	17	2461	2	5.0	.8	1.85	1.16	61.93	1.063	2.41	10.67	2.63	Dark green, some starch.
28	17	2618	1	7.8	.8	1.20	.80	60.55	1.048	3.90	6.08	3.76	Do.
28	17	2619	2	6.0	.8	1.54	.97	55.43	1.039	3.75	2.10	2.49	Do.
28	17	2620	1	8.3	.9	1.70	1.02	64.98	1.055	3.35	8.18	2.07	Do.
28	17	2621	2	6.5	.7	1.91	.99	67.33	1.068	1.28	12.44	2.81	Do.
Oct. 1	*17	2698	1	4.5	.9	.88	.66	64.20	1.053	2.46	8.09	4.03	Dark brown.
4	17	2748	1	7.6	.8	1.05	.77	56.59	1.062	3.04	10.20	2.58	Dirty green.
7	17	2816	2	7.2	.8	1.85	.92	56.19	1.063	2.53	10.09	2.97	Do.
11	17	2908	1	8.6	.9	1.48	.99	68.14	1.067	Lost.	Lost.	Lost.	Brown.
13	17	2978	1	7.9	.9	1.28	.91	66.99	1.073	3.01	11.58	3.36	Very dark olive.
15	17	3010	1	8.4	.8	1.80	1.14	65.38	1.077	Lost.	Lost.	Lost.	Very dark green.
16	18	3047	1	7.8	.7	.81	.67	63.08	1.060	2.84	6.98	5.46	Dirty green.
19	18	3104	1	7.8	.9	1.58	1.09	69.90	1.061	2.53	10.07	3.38	Dark brown.
20	17	3131	1	7.5	.7	1.41	.96	61.62	1.076	1.53	13.72	5.31	
22	17	3166	1	8.3	.9	1.33	.91	64.41	1.070	2.98	11.04	4.02	Dirty green.
25	17	3221	1	8.0	.8	1.21	.94	64.02	1.074	3.20	12.51	2.49	Green.
27	17	3277	1	8.4	.8	1.39	1.01	59.17	1.079	2.21	14.52	3.57	Light green.
29	17	3316	1	8.4	.8	1.48	.99	62.83	1.075	2.69	12.36	Lost.	Dark brown.
30	18	3346	1	8.4	.8	1.58	1.20	66.91	1.071	2.10	9.65	Lost.	Light green.
Nov. 3	18	3395	2	5.7	.6	.92	.77	59.89	1.064	1.83	10.33	4.15	Olive.
5	18	3431	1	8.0	.8	1.29	.95	54.17	1.067	2.52	11.87	1.54	Dirty green.
10	18	3488	1	8.5	1.0	1.54	1.16	70.32	1.061	2.64	10.48	2.83	Light olive.
12	18	3509	2	8.0	.6	1.10	.93	62.17	1.060	3.37	8.60	4.87	Brownish olive.
15	18	3538	1	8.0	.9	1.41	1.14	68.86	1.066	1.90	11.92	2.25	Dark green.

* Topped August 28.

TABLE No. 38.—HYBRID. J. C. MOORE, SAN DIEGO, CAL.

July 15	1	11	2	7.5	0.9	......	2.53	44.68	1.017	2.70	.83	.53	
19	2	47	1	9.5	.8	1.97	1.51	52.88	1.724	3.85	.64	1.61	
20	3	66	1	9.1	.9	2.15	1.56	53.22	1.023	1.89	1.33	2.28	
22	4	104	1	7.0	.8	2.04	1.31	65.93	1.022	1.87	......	......	

ANALYSES OF JUICES FROM SORGHUM—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
July 24	4	149	1	8.4	1.0	2.47	1.80	58.88	1.022	2.60	.82	2.35	Dark green.
22	5	105	1	8.7	.8	2.22	1.50	61.96	1.024	3.27	2.35	1.02	
24	5	150	1	9.5	....	2.07	1.49	59.82	1.027	2.10	2.40	2.71	Light green, little starch.
22	6	106	1	8.5	.7	2.17	1.39	47.33	1.025	3.02	4.02	......	
24	6	151	1	8.5	.8	1.98	1.37	65.60	1.025	1.59	2.83	2.70	Dark green, starchy.
23	7	133	1	8.6	.6	1.25	.85	63.43	1.031	2.21	3.60	1.95	Light green.
26	8	178	1	7.5	.9	2.22	1.42	62.48	1.027	1.10	3.87	1.85	Dark green.
27	9	228	1	9.3	.8	2.07	1.55	73.63	1.032	2.91	2.88	2.54	Do.
29	9	257	1	9.3	.7	1.68	1.23	69.30	1.026	2.72	1.44	2.18	Do.
30	9	292	1	9.9	.8	2.16	1.57	66.95	1.029	1.77	2.96	2.30	Lighter green, starchy.
31	9	338	1	9.0	.9	1.64	1.49	71.05	1.030	1.85	3.15	2.57	Do.
Aug. 2	9	362	1	9.7	.7	1.54	1.10	68.92	1.038	2.78	4.43	2.33	Light green, starchy.
3	9	394	1	9.5	.5	1.80	1.29	52.65	1.036	1.48	5.63	1.53	Do.
4	10	435	1	8.5	.8	1.79	1.14	72.69	1.020	1.36	1.38	1.97	Do.
6	9	518	1	8.5	.4	1.95	1.30	71.69	1.016	1.14	.17	2.48	Thin; watery.
9	12	581	1	8.8	.7	1.66	.83?	88.89?	1.018	1.18	7.93	2.35	Do.
10	11	594	1	8.5	.9	2.24	1.49	69.72	1.022	2.39	.56	2.58	Dark green; watery.
7	10	546	1	9.5	.8	1.73	1.19	67.22	1.029	1.58	3.23	2.33	Light green, watery.
7	10	547	1	8.8	.8	1.89	1.29	69.57	1.039	2.11	4.79	2.68	Do.
7	10	548	1	9.5	.8	1.64	1.19	69.63	1.037	1.75	4.43	2.69	Do.
7	10	549	1	8.5	.8	1.44	.96	68.19	1.039	1.61	5.10	2.72	Darker green, watery.
10	12	602	1	9.7	.8	2.26	1.54	69.02	1.020	1.22	1.14	2.40	Dark green, watery.
10	12	603	1	8.6	.9	2.90	1.19	71.40	1.027	1.52	2.14	2.82	Do.
10	12	604	1	8.5	1.0	2.09	1.47	70.46	1.021	1.47	1.40	2.27	Do.
10	12	605	1	8.4	.9	1.71	1.21	70.91	1.025	1.42	1.31	2.88	Do.
14	12	795	1	9.0	.8	1.82	1.17	70.19	1.018	1.17	.14	2.86	Do.
14	12	796	1	9.1	.9	1.95	1.34	68.70	1.041	1.54	4.51	3.89	Do.
14	12	797	1	9.0	.9	1.95	1.16	68.06	1.027	1.61	2.26	2.56	Do.
14	12	798	1	8.9	1.0	1.94	1.31	60.06	1.043	1.48	5.79	3.13	Do.
17	13	899	1	8.5	.9	2.31	1.40	72.06	1.019	1.30	.64	2.33	Dark green, starchy.
17	13	900	1	8.5	.9	1.64	1.12	68.00	1.022	1.08	.99	2.92	Do.
17	13	901	1	9.2	.9	1.67	1.22	69.96	1.029	1.25	2.15	3.06	Do.
17	13	902	1	8.0	.8	1.38	.97	68.82	1.037	2.01	3.70	2.92	Do.
21	14	1080	1	10.0	.9	1.95	1.83	54.13	1.027	1.64	2.89	2.13	Thin, watery.
21	14	1081	1	9.4	.9	1.93	1.37	69.82	1.041	1.67	6.01	2.50	Do.
21	14	1082	1	8.5	.8	1.69	1.18	73.69	1.034	3.15	3.30	2.08	Do.
21	14	1083	1	8.6	.8	1.64	1.18	69.50	1.036	1.60	4.42	2.47	Do.
Sept. 6	16	1717	1	9.1	1.0	1.98	1.37	69.46	1.027	2.58	1.75	2.29	Dark green, starchy.
6	16	1718	1	10.0	1.0	1.76	1.37	68.16	1.031	1.82	3.18	2.32	Do.
6	16	1719	1	9.4	.9	1.58	1.11	67.32	1.054	.97	9.44	2.40	Do.
6	16	1720	1	8.7	.9	1.67	1.15	65.31	1.040	.93	5.10	3.54	Do.
14	16	1965	1	9.8	1.1	2.03	1.37	81.08?	1.038	1.44	4.87	2.36	Light green, some starch.
14	16	1966	1	9.1	1.0	1.86	1.33	69.20	1.052	1.81	7.74	2.62	Do.
14	16	1967	1	8.1	1.0	1.32	.87	65.59	1.038	.63	5.06	2.84	Do.
14	16	1968	1	8.2	1.0	1.70	1.16	72.00	1.050	1.13	7.05	3.15	Do.
23	17	2330	1	9.1	.9	2.46	1.22	66.06	1.039	.69	5.52	3.13	Dark green, some starch.
23	17	2331	1	8.4	.8	1.37	.97	64.25	1.052	1.87	7.44	3.19	Do.
23	17	2332	1	8.5	.9	1.97	1.28	70.69	1.051	1.45	7.70	2.84	Do.
23	17	2333	1	9.0	.8	1.52	1.02	66.81	1.047	2.18	6.27	2.49	Do.
28	17	2634	1	9.3	.9	1.87	1.21	65.57	1.040	2.51	5.72	1.71	Do.
28	17	2635	1	8.6	1.0	2.20	1.35	66.82	1.046	1.97	5.57	3.12	Do.
28	17	2636	1	9.0	1.0	2.08	Lost.	Lost.	1.042	1.15	5.69	2.61	Do.
28	17	2637	1	8.4	1.0	1.93	1.16	65.27	1.051	.99	8.42	2.44	Do.
Oct. 1	17*	2702	1	6.6	.9	.98	.73	68.86	1.048	.54	7.13	4.31	Green.
5	17	2755	1	6.7	.8	1.21	.77	68.67	1.034	1.23	4.09	2.80	Dark olive.
7	17	2820	1	9.3	.9	2.07	1.26	69.05	1.055	2.87	7.74	2.75	Green.
12	17	2935	1	8.4	1.0	1.63	1.10	69.32	1.041	3.18	4.03	2.78	Light green, starchy.
13	17	2982	1	8.1	.9	2.08	1.06	66.87	1.054	.78	8.92	3.15	Do.
22	....	3170	1	10.4	1.0	1.54	1.12	63.92	1.056	1.66	7.67	5.02	Dark green.
25	....	3225	1	.....	....	......	.97	64.03	Lost.	.98	6.77	Lost.	
27	....	3281	1	9.5	1.1	1.39	1.12	Lost.	1.058	4.38?	10.09	......	Light green.
29	....	3323	1	8.6	.9	1.34	.96	69.44	1.048	1.58	6.32	2.93	Light brown.
30	....	3350	1	9.5	1.0	1.38	1.24	65.84	1.049	2.74	6.27	9.29?	Dirty green.

* Topped August 28.

JUICES FROM CORNSTALKS.

Although a considerable number of analyses of the juice obtained from cornstalks has been made, we are, as yet, not willing to positively assert that sugar can be made at a profit from the juice of cornstalks. Still, the results of the analyses, taken with those from practical experiments on a small scale, make the outlook appear very hopeful.

The following are some practical results obtained this year:

The stalks from four varieties of field corn were used, viz: Improved Prolific, White Dent, Lindsay's Horse-Tooth, Eight-rowed White Dent.

One hundred and twenty-one pounds of stripped stalks yielded 62 pounds of juice, equal to 51.24 per cent. of juice. This juice contained 8.55 per cent. of crystallizable sugar, as shown by the polariscope.

Fifty-three pounds of this juice yielded 8.5 pounds of sirup, equal to 16 per cent. This sirup contained sucrose 50.44 per cent., glucose 11.50 per cent., or 94.64 per cent. of the sucrose originally present in the juice was recovered in the sirup. There were actually separated from this sirup 4.5 pounds of sugar, equal to 53.00 per cent. of the sirup.

A similar experiment conducted in 1879 furnished a sirup from which 39.3 per cent. of good sugar was actually separated.

While the yield of sugar per acre is considerably less than from sorghum, it must be borne in mind that good mature corn can first be produced and sold; if, then, the sugar obtained from the otherwise almost worthless stalks can be made at even a small profit, it will equal or exceed in value the sum received for the corn.

It is hoped that practical experiments on a large scale may be conducted during the coming summer. The results then obtained will do much to settle this question as to the cost of producing sugar from cornstalks. If successful, a very great saving can be annually made in this country.

ANALYSES OF JUICES FROM CORNSTALKS.

TABLE NO. 39.—RICE OR EGYPTIAN CORN. ROOT & HOLLINGSWORTH, KINSLEY COURT-HOUSE, KANS.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juices expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	In.	Lbs.	Lbs.	Pr. ct.		Pr. ct.	Pr. ct.	Pr. ct.	
July 26	1	184	3	6.4	0.6	1.84	1.07	44.75	1.031	1.18	3.28	2.80	Light green, starchy.
26	2	185	2	6.7	.6	1.49	.96	45.52	1.029	.88	3.03	2.89	Dark green.
26	3	192	2	6.8	.6	1.53	.91	43.98	1.026	.92	2.97	2.64	Do.
27	4	231	1	7.0	.8	1.19	.79	48.92	1.038	1.26	5.03	3.20	Light green, starchy.
30	4	300	1	7.4	.6	1.18	.63	40.04	1.046	1.11	5.88	4.00	Dark green, starchy.
31	5	342	1	7.4	.7	1.11	.75	48.08	1.052	1.09	6.95	4.22	Light green.
Aug. 2	5	370	1	7.8	.8	.93	.57	46.18	1.048	4.32	4.03	4.10	Do.
7	6	553	3	6.5	.6	2.09	1.21	48.72	2.047	.76	6.42	4.23	Dark green, watery, starchy.
7	7	554	2	6.7	.8	1.88	1.16	46.67	1.056	1.12	8.26	4.11	Do.
9	7	589	1	6.9	.8	2.34	1.47	53.67	1.046	.96	6.61	3.71	Dark green, starchy.
11	8	678	2	7.5	.7	2.23	1.29	50.76	1.051	1.13	7.40	3.84	Do.
19	8	973	3	7.6	.7	2.39	1.44	45.50	1.057	.96	9.54	3.69	Do.
19	8	974	3	6.0	.6	1.94	1.13	40.85	1.063	.95	9.93	4.41	Do.
19	8	975	3	5.6	.6	2.11	1.17	46.99	1.061	1.50	9.39	4.05	Do.
19	9	976	3	7.0	.7	3.01	1.63	47.71	1.054	.68	8.41	4.48	Do.
19	9	977	3	7.5	.7	2.63	1.40	46.45	1.054	.61	8.66	2.97?	Do.
19	9	978	3	6.0	.7	2.93	1.44	48.55	1.052	.92	7.28	4.78	Do.
23	9	1129	2	7.5	.7	2.02	1.04	53.39	1.041	.71	5.91	3.37	Do.
23	9	1130	2	7.5	.8	2.57	1.34	46.95	1.053	.64	7.67	4.61	Do.

ANALYSES OF JUICES FROM CORNSTALKS—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Aug. 26	9	1253	2	7.5	0.7	2.05	1.01	47.29	1.049	0.77	7.53	3.14	Dark green, starchy.
26	9	1254	1	8.0	.8	1.65	.87	46.21	1.049	.61	7.44	3.44	Do.
26	9	1255	1	7.0	.8	1.52	.69	52.23	1.047	.84	6.97	3.03	Do.
28	10	1379	2	8.0	.8	2.49	1.17	46.44	1.038	.60	5.65	3.34	Do.
28	10	1380	2	8.5	.7	2.23	1.12	42.01	1.045	.68	5.94	4.19	Do.
28	10	1381	2	6.6	.7	1.87	.86	31.24	1.032	.78	2.82	3.81	Do.
Sept. 3	10	1603	2	7.1	.7	1.98	.97	54.77	1.032	.55	4.62	2.82	Do.
3	10	1604	2	7.3	.7	2.02	.88	44.03	1.040	.64	5.47	3.31	Do.
3	10	1605	3	5.5	.6	2.03	.79	43.33	1.034	.60	3.35	3.94	Do.
8	11	1808	2	7.6	.6	1.46	.78	29.18	1.041	.39	5.54	3.27	Dark green, some starch.
8	11	1809	2	7.0	.6	1.40	.81	25.40	1.040	.43	4.41	3.48	Do.
8	11	1810	3	5.6	.7	2.02	.57	64.20	1.035	.34	3.35	4.18	Do.
8	12	1815	2	8.6	.8	2.44	1.29	47.78	1.056	.47	10.05	......	Do.
8	12	1816	2	7.6	.7	2.02	.97	42.40	1.032	.45	3.42	4.41	Do.
8	12	1817	2	7.0	.7	2.37	1.11	44.38	1.036	.46	3.62	......	Do.
9	11	1896	2	7.9	.9	2.55	1.36	49.75	1.051	.42	7.90	3.46	Dark green, starchy.
9	11	1897	3	8.0	.7	1.79	.86	44.08	1.054	.38	7.59	1.19	Do.
9	11	1898	2	6.9	.7	1.85	.84	44.21	1.037	.40	3.24	3.30	Do.
15	14	2011	2	7.7	.8	2.00	1.03	49.14	1.050	.54	7.18	3.83	Do.
15	14	2012	2	7.6	.8	1.81	1.00	40.00	1.059	.56	9.18	3.90	Do.
15	14	2013	2	5.7	.7	1.87	.98	42.56	1.048	.65	5.83	4.21	Do.
18	14	2131	3	8.7	.7	2.79	1.66	37.74	1.062	.35	9.50	4.18	Do.
18	14	2132	3	8.0	.7	2.71	1.51	38.65	1.062	.68	9.44	1.84	Do.
18	14	2133	2	6.9	.7	1.87	.94	41.45	1.051	.42	7.96	2.32	Do.
21	1	2249	19	4.0	.4	2.95	1.07	51.13	1.031	1.58	3.11	2.73	Dark green, some starch.
22	15	2297	2	8.6	.7	1.21	.69	32.63	1.066	.72	11.29	3.47	Do.
22	15	2298	2	8.0	.8	1.83	.99	42.92	1.067	.61	11.66	3.33	Do.
22	15	2299	2	7.4	.8	1.50	1.09	43.24	1.051	.67	8.11	2.97	Do.
27	16	2527	4	7.6	.8	4.17	1.78	66.66	1.068	.34	10.84	4.59	Dark green, starchy.
27	16	2528	4	8.1	.7	3.08	1.76	69.82	1.067	.60	10.58	4.47	Do.
27	16	2529	5	6.6	.8	3.99	1.78	79.82?	1.063	.47	11.59	2.71	Do.
Oct. 6	16	2782	3	7.6	.8	2.00	1.17	63.65	1.071	.34	12.76	4.28	Do.
8	16	2870	2	7.4	.8	1.61	1.12	46.83	1.056	.45	9.13	3.85	Green.
16	....	3067	5	5.6	.5	1.91	1.09	48.49	1.045	1.09	11.92	......	Dark green.
26	....	3251	4	5.0	.7	1.60	1.51	35.62	1.079	.96	13.53	3.67	Do.

TABLE No. 40.—DOURA CORN. ———, S. C.

Aug. 21	E	1084	1	9.5	1.1	2.79	2.36	52.00	1.037	2.23	4.98	2.34	Thin, watery.
26	E	1288	1	9.1	1.2	2.66	1.83	51.80	1.041	2.82	4.60	2.42	Dark green, starchy.
Sept. 6	1	1741	1	7.7	.6	.87	.58	46.04	1.043	2.37	5.37	2.95	Dark green, some starch.
6	2	1742	2	7.7	.5	1.23	.78	44.19	1.043	2.00	5.45	3.00	Do.
7	3	1783	1	9.3	1.1	2.26	1.46	54.28	1.047	2.42	6.20	2.61	Dark green, starchy.
7	4	1784	1	10.6	1.1	2.41	1.86	50.41	1.042	2.62	4.58	2.92	Do.
7	5	1795	1	11.5	1.1	2.70	2.05	49.46	1.042	2.11	5.86	2.35	Do.
15	1	2022	2	7.4	.8	1.45	.92	44.84	1.052	2.16	6.39	3.33	Do.
23	8	2354	1	10.0	1.1	3.19	2.07	40.75	1.050	2.46	7.16	2.43	Dark green, some starch.
Oct. 16	....	3065	1	9.3	.7	1.13	.77	38.22	1.078	1.75	12.44	4.92	Dark green.
22	....	3185	1	8.8	.9	1.94	1.54	44.16	1.077	1.53	12.77	4.08	Olive.
26	....	3249	1	8.6	1.0	1.72	1.43	48.31	1.076	2.64	13.05	2.62	Dark green.

TABLE No. 41.—STOWELL'S EVERGREEN. W. R. SHELMIRE, CHESTER, PA.

Aug. 14	1	778	2	5.6	0.8	1.65	.70	70.31	1.048	3.13	7.39	1.88	Dark green.
14	2	779	2	5.9	.8	1.93	1.15	52.29	1.065	1.84	10.57	3.69	Do.
21	3	1044	2	7.0	1.1	2.82	1.91	54.89	1.067	1.32	12.07	3.39	Dark green, starchy.
28	4	1387	2	6.0	.9	1.58	1.16	58.16	1.050	1.39	9.96	3.62	Do.
Sept. 4	5	1664	1	6.0	.9	1.27	.48	40.22	1.061	.87	10.70	3.89	Do.
8	Y Y	1823	3	6.0	1.0	2.94	2.13	58.76	1.040	1.60	6.20	2.06	Dark green, some starch.
10		1910	3	7.0	1.0	2.20	1.70	58.52	1.044	1.68	6.77	1.79	Dark green, starchy.

ANALYSES OF JUICES FROM CORNSTALKS—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Sept. 11	4	1922	3	5.6	1.0	1.50	1.16	49.34	1.066	1.25	10.71	3.99	Dark green, some starch.
11	6	1930	1	7.0	.9	1.33	.55?	92.74?	1.072	.93	12.01	5.22	Do.
13	Y	1949	3	5.3	1.0	2.27	2.05	58.04	1.063	1.06	11.05	2.47	Dark green, starchy.
18	7	2111	4	6.0	1.0	3.30	2.78	54.03	1.066	.88	11.26	2.59	Do.
18	5	2112	4	5.6	.8	1.70	2.42	31.15	1.065	1.20	10.81	4.37	Do.
18	Z	2119	2	6.0	1.0	1.63	1.28	60.30	1.060	1.14	9.51	3.97	Do.

TABLE No. 42.—EGYPTIAN SUGAR. W. R. SHELMIRE, CHESTER, PA.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
July 28	1	247	2	7.4	1.0	4.29	2.35	59.47	1.042	2.82	5.24	2.35	Very dark green.
31	1	328	2	7.7	.9	3.79	2.61	67.42	1.035	1.87	4.81	2.06	Dark green.
Aug. 7	2	555	2	7.0	1.0	3.50	2.40	58.33	1.054	2.17	8.98	2.61	Dark green, watery starchy.
14	3	771	2	8.0	1.1	1.98	2.19	58.59	1.059	1.53	10.04	2.82	Brown, starchy.
21	4	1040	2	8.0	1.0	3.01	2.27	47.06	1.064	1.28	11.15	3.17	Dark green, starchy.
28	5	1383	1	8.2	1.1	1.46	1.27	54.49	1.065	1.54	10.65	3.87	Do.
Sept. 4	6	1660	1	7.7	1.0	1.14	.98	57.54	1.058	1.37	10.82	2.74	Do.
8	Y	1819	1	7.5	1.1	2.60	2.09	62.87	1.053	1.33	8.98	2.42	Dark green, some starch.
10	Y	1906	1	7.0	1.0	1.21	.92	61.19	1.057	1.18	8.85	2.78	Dark green, starchy.
11	7	1918	1	6.0	1.0	.51	.43	46.70	1.053	1.78	5.58?	5.45?	Dark green, some starchy.
11	Y	1928	2	7.5	1.0	1.83	1.43	....	1.066	.79	11.00	3.31	Do.
13	Y	1939	2	7.0	.9	1.14	.94	62.12	1.044	2.21	6.64	1.73	Do.
13	Y	1940	1	8.0	1.0	1.38	.92	58.33	1.071	1.57	12.14	3.04	Do.
18	Z	2115	3	7.8	1.3	2.97	2.79	61.57	1.058	1.28	9.11	1.80	Dark green, starchy.
23	Y	2356	1	6.0	1.0	.75	.66	59.00	1.052	2.66	9.03	1.37	Dark green, some starch.
23	Y	2357	1	7.3	1.1	1.23	1.07	56.97	1.061	1.56	10.92	2.46	Do.
23	Y	2358	1	8.0	1.1	1.67	1.50	64.08	1.057	2.83	8.24	2.55	Do.
23	Y	2359	1	8.0	1.2	1.08	1.05	55.88	1.061	2.33	8.64	3.50	Do.
23	Y	2360	1	7.6	1.1	.68	.66	55.63	1.068	1.38	11.03	4.16	Do.
28	....	2650	1	7.0	1.0	.88	.76	47.55	1.059	2.66	8.13	3.42	Do.
28	....	2651	1	7.0	1.0	.77	.65	48.47	1.048	1.26	6.57	2.90	Do.
28	....	2652	1	8.6	1.0	.94	.84	56.51	1.057	1.45	8.84	3.53	Do.
Oct. 23	....	3195	2	7.7	1.1	1.67	1.23	40.14	1.075	1.87	9.22	6.16	Dark green.

TABLE No. 43.—LINDSAY'S HORSE-TOOTH. A. H. LINDSAY, PORTSMOUTH, VA.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
Aug. 14	1	769	2	8.3	1.0	5.48	3.25	63.45	1.045	2.37	6.72	2.20	Dark green, starchy.
14	2	770	2	9.8	1.3	6.72	4.85	63.80	1.049	1.36	8.48	2.55	Do.
21	3	1039	2	9.6	1.2	6.20	4.15	51.91	1.065	1.61	11.00	3.54	Do.
28	4	1382	1	8.3	1.2	2.74	2.13	54.12	1.060	1.04	9.61	4.11	Do.
Sept. 4	5	1659	1	9.5	1.2	2.47	1.85	55.11	1.079	.89	15.16	3.27	Do.
8	Y	1818	1	10.0	1.3	3.94	3.05	60.13	1.056	1.37	9.27	1.95	Dark green, some starch.
10	Y	1905	1	8.0	1.1	2.14	1.71	61.85	1.043	1.44	6.85	1.82	Dark green, starchy.
11	6	1917	1	10.3	1.5	3.15	2.35	54.95	1.060	.94	9.97	3.56	Dark green, some starch.
11	Y	1925	1	8.0	1.2	1.86	1.65	64.67	1.058	Lost.	Lost.	Lost.	Do.
11	Y	1926	1	8.5	1.0	2.05	1.62	50.61	1.054	1.43	8.49	2.84	Do.
11	Y	1927	2	8.6	1.0	2.82	1.83	63.07	1.026	.41	2.56	3.22	Do.
13	Y	1937	1	8.2	1.3	2.68	1.93	60.32	1.061	1.12	10.41	3.32	Do.
13	Y	1938	1	9.0	1.3	2.25	1.56	65.97	1.031	.72	3.58	2.78	Do.
18	7	2107	1	11.0	1.3	2.73	2.50	57.35	1.065	1.12	8.97	5.45	Dark green, starchy.
20	Z	2200	2	8.5	1.2	3.70	2.88	58.17	1.057	.85	9.64	3.32	Do.
21	Y	2237	1	7.5	1.3	2.20	1.61	58.42	1.062	1.32	10.67	3.36	Thin, watery.
21	Y	2238	1	10.0	1.2	2.35	1.76	51.87	1.070	1.04	11.89	4.03	Do.
21	Y	2239	1	9.0	1.3	2.50	2.13	63.29	1.033	1.37	4.76	1.95	Do.
21	Y	2240	1	9.3	1.2	1.93	1.67	65.26	1.025	.76	3.31	2.17	Do.
21	Y	2241	1	9.0	1.1	1.78	1.44	54.81	1.072	.77	13.68	3.11	Do.
21	Y	2242	1	8.3	1.2	1.59	1.08	63.26	1.031	.36	4.77	2.39	Do.
21	Y	2243	1	9.6	1.2	2.25	1.91	59.96	1.058	1.55	10.07	2.65	Do.

ANALYSES OF JUICES FROM CORNSTALKS—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Sept. 21	Y	2244	1	7.5	1.2	1.85	1.66	64.10	1.047	1.61	7.09	3.14	Dark green, some starch.
21	Y	2245	1	8.0	1.3	2.37	1.96	58.20	1.073	1.06	13.16	3.68	Do.
21	Y	2246	1	7.5	1.2	1.58	1.34	55.42	1.053	1.26	9.97	2.10	Do.
21	Y	2247	1	8.0	1.2	1.66	1.37	62.10	1.042	.74	6.56	2.92	Do.
21	Y	2248	1	10.3	1.1	1.71	1.38	46.01	1.037	.52	5.00	3.35	Do.
25	8	2516	1	9.0	1.3	3.63	2.71	56.23	1.065	.59	11.88	4.29	Do.
Oct. 6	....	2795	1	8.5	1.1	1.62	1.38	63.69	1.065	.70	11.42	3.75	Dark green, starchy.
6	....	2796	1	9.5	1.3	2.15	2.00	66.95	1.064	1.05	11.62	3.22	Do.
6	....	2797	1	6.6	.8	.86?	1.34	67.75	1.039	.42	6.16	3.00	Do.
6	....	2798	1	8.3	1.2	2.21	1.70	65.11	1.062	.55	11.21	3.73	Do.
6	....	2799	1	9.1	1.3	2.84	2.16	65.95	1.063	.83	11.43	3.51	Light green.
6	....	2800	1	8.6	1.0	1.71	1.35	59.99	1.062	.64	11.25	3.88	Do.
6	....	2801	1	9.1	1.1	1.67	1.19	52.03	1.064	.65	11.33	4.01	Do.
6	....	2802	1	10.0	1.2	1.75	1.47	61.48	1.065	.75	11.24	4.12	Do.
6	....	2803	1	9.3	1.2	1.98	1.64	66.88	1.041	1.18	6.80	2.25	Do.
6	....	2804	1	9.7	1.1	1.50	1.08	78.58?	1.037	1.18	4.56	3.13	Do.
16	9	3068	2	8.0	1.2	3.43	3.00	65.05	1.068	.73	14.65	3.63	Dark green.
23	....	3194	2	7.5	1.2	3.23	2.51	61.21	1.059	.86	8.94	4.74	Do.
23	10	3202	2	9.1	1.3	4.11	3.53	56.45	1.074	.77	12.10	5.28	Do.

TABLE No. 44.—WHITE FLAT DENT, 8-ROWED. WASHINGTON MARKET.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
Aug. 14	1	774	2	9.8	1.1	3.74	3.18	63.26	1.040	1.23	6.12	2.62	Brown, starchy.
14	2	775	2	10.0	1.2	5.14	3.47	63.33	1.049	1.12	7.63	3.26	Dark green.
21	3	1042	2	8.5	1.2	4.83	3.62	59.14	1.050	.85	10.93	.60	Dark green, starchy.
28	4	1385	1	9.6	1.2	2.68	2.17	50.88	1.064	.86	10.93	4.14	Do.
Sept. 4	5	1662	1	9.0	1.3	2.46	2.03	61.97	1.055	1.30	9.44	2.96	Do.
8	Y	1821	1	9.6	1.2	2.10	1.71	64.05	1.034	1.05	4.88	2.48	Dark green, some starch.
10	Y	1908	1	8.5	1.1	2.23	1.40	63.42	1.047	.98	7.83	2.22	Dark green, starchy.
11	6	1920	1	9.4	1.3	2.01	1.73	54.95	1.067	.70	11.40	3.97	Dark green, some starch.
11	Y	1933	1	9.5	1.0	1.43	1.02	47.52	1.021	.34	1.77	7.10?	Do.
11	Y	1934	1	9.0	1.3	1.94	1.46	60.30	1.041	2.03	5.57	4.37	Do.
13	Y	1944	1	9.8	1.1	1.86	1.44	61.93	1.032	1.51	3.16	2.31	Do.
13	Y	1945	1	9.3	1.2	2.16	1.62	64.35	1.062	.85	11.72	2.31	
13	Y	1946	1	10.8	1.0	2.06	1.58	64.03	1.043	2.16	5.85	2.05	Dark green, starchy.
18	5	2109	1	9.0	1.2	1.71	1.50	54.55	1.065	1.12	10.71	3.19	Do.
18	Z	2117	2	9.2	1.3	4.88	3.89	63.19	1.057	.87	10.02	2.73	Do.
25	6	2514	1	5.0	1.0	1.10	.94	58.11	1.063	.76	10.00	5.42	Do.
Oct. 16	9	3070	1	9.3	1.3	1.94	1.79	64.29	1.068	.42	12.28	4.29	Dark green, some starch.
23	....	3197	1	8.0	1.4	1.72	1.61	66.03	1.054	.42	7.60	5.21	Dark green.
23	10	3201	3	9.0	1.1	2.57	2.16	42.65	1.066	1.04	9.37	5.40	Do.

TABLE No. 45.—IMPROVED PROLIFIC. JAMES M. THORBURN & CO., NEW YORK CITY.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
Aug. 14	1	776	2	8.3	1.1	4.07	2.62	44.75	1.042	2.43	5.65	2.38	Dark green.
14	2	777	2	9.3	1.3	6.26	4.66	64.00	1.042	1.22	6.13	2.82	Do.
21	3	1043	2	9.2	1.2	5.87	4.19	57.29	1.061	.97	10.92	3.10	Dark green, starchy.
28	4	1386	1	8.3	1.0	1.58	1.31	56.70	1.062	.76	10.42	4.26	Do.
Sept. 4	5	1663	1	9.7	1.2	2.14	1.75	58.74	1.067	.80	11.98	3.76	Do.
8	Y	1822	1	10.6	1.3	2.35	1.82	59.12	1.027	.90	2.50	3.08	Dark green, some starch.
10	Y	1909	1	9.4	1.4	2.51	1.96	61.99	1.059	1.36	12.02	1.16	Dark green, starchy.
11	6	1921	1	10.5	1.7	5.16	4.07	67.35	1.061	1.04	9.99	4.10	Dark green, some starch.
11	Y	1935	1	8.0	1.0	1.32	1.07	61.52	1.035	.42	3.93	2.41	Do.
11	Y	1936	1	10.0	1.0	1.33	.95	45.96	1.023	.61	1.72	2.26	Do.
13	Y	1947	1	9.8	1.1	1.58	1.05	63.05	1.026	1.02	2.71	2.26	Dark green, starchy.
13	Y	1948	1	7.4	1.2	1.43	1.09	64.37	1.031	2.71	1.62	1.94	Do.
18	7	2110	1	9.5	1.2	1.77	1.53	51.93	1.055	.55	9.85	3.34	Do.
18	Z	2118	3	8.0	1.2	3.37	2.56	54.97	1.022	.09	1.23	2.25	Thin, watery.

ANALYSES OF JUICES FROM CORNSTALKS—Continued.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
Sept. 25	6	2512	1	8.8	1.2	1.76	1.61	44.05	1.061	1.35	9.57	4.11	Dark green, some starch.
25	8	2513	1	7.8	.9	.81	.74	52.23	1.060	.65	9.60	4.28	Do.
Oct. 16	9	3071	1	9.0	1.3	1.78	1.49	57.37	1.065	1.31	9.85	4.85	Dark green.
23	....	3198	1	8.0	1.2	1.38	.99	54.22	1.054	3.02	6.98	3.38	Do.
23	10	3200	3	8.5	1.2	3.59	3.15	53.98	1.071	1.21	11.23	5.12	Do.

TABLE No. 46.—WHITE DENT. THOMAS L. JONES, WARRENTON, N. C.

Aug. 14	1	772	2	9.0	1.1	4.74	3.26	61.92	1.046	2.50	7.06	1.96	Brown, starchy.
14	2	773	2	9.6	1.5	5.48	3.90	60.20	1.058	1.51	9.57	3.19	Do.
21	3	1041	2	10.0	1.2	7.71	5.32	58.69	1.062	1.87	10.78	2.79	Brownish green.
28	4	1384	1	11.3	1.1	2.63	2.07	55.53	1.062	1.01	10.53	3.71	Dark green, starchy.
Sept. 4	5	1661	1	8.7	1.1	1.92	1.50	61.39	1.059	.85	10.50	5.08	Do.
4	6	1688	1	10.0	1.3	2.40	1.81	62.62	1.057	1.64	(*)	......	Do.
8	Y	1820	1	9.0	1.1	2.35	1.71	48.77	1.064	1.53	11.48	2.50	Dark green, some starch.
10	Y	1907	1	10.0	1.3	1.89?	2.27	53.63	1.065	1.47	12.61	1.55	Dark green, starchy.
11	4	1919	1	7.0	.9	1.01	.75	46.49	1.073	.93	12.78	3.67	Dark green, some starch.
11	Y	1929	1	9.3	1.0	1.91	1.36	68.12	1.050	1.19	7.42	2.87	Do.
11	Y	1931	1	8.0	1.0	1.56	1.02	62.15	1.038	2.05	4.74	1.92	Do.
11	Y	1932	1	10.5	1.2	2.60	1.82	58.33	1.041	1.53	5.27	2.47	Do.
13	Y	1941	1	8.6	1.2	2.38	1.75	63.50	1.047	1.28	6.72	2.84	Do.
13	X	1942	1	8.6	1.2	2.29	1.66	65.56	1.046	1.85	7.09	2.00	Do.
18	Y	1943	1	10.9	1.1	2.80	2.06	58.48	1.045	1.27	7.62	1.59	Do.
18	8	2108	1	8.0	1.0	1.26	.92	44.60	1.073	1.36	12.91	1.76	Dark green, starchy.
18	Z	2116	2	9.5	1.1	3.67	2.77	56.42	1.053	1.34	8.43	3.15	Do.
23	Y	2361	1	8.0	1.1	1.28	1.07	56.97	1.056	1.03	9.70	2.80	Dark green, some starch.
23	Y	2362	1	8.0	1.1	1.76	1.52	61.56	1.065	1.91	12.10	2.09	Do.
23	Y	2363	1	10.5	1.3	2.83	2.22	61.90	1.068	1.11	12.44	3.06	Do.
23	Y	2364	1	7.4	1.0	1.37	1.07	57.53	1.046	1.05	8.02	2.16	Do.
23	Y	2365	1	8.0	1.2	1.92	1.23	73.06	1.049	.77	7.76	2.96	Do.
23	Y	2366	1	9.0	1.2	1.27	1.48?	37.83?	1.019	1.19	1.95	1.13	Do.
24	Y	2435	1	8.9	1.3	1.50	1.11	55.75	1.028	1.93	3.39	2.02	Dark brown, starchy.
24	Y	2436	1	7.5	1.2	1.43	1.07	47.95	1.056	.59	9.78	3.69	Dark green, some starch.
24	Y	2437	1	8.6	1.1	.98	.87	55.19	1.067	1.10	10.77	4.72	Do.
24	Y	2438	1	7.5	1.1	1.47	1.02	49.56	1.068	.82	11.03	5.24	Do.
24	Y	2439	1	7.7	.9	.88	.65	58.44	1.027	.79	4.91	1.12	Do.
24	Y	2440	1	10.0	1.1	1.94	1.58	62.25	1.040	1.12	6.41	2.61	Do.
24	Y	2441	1	9.3	1.2	1.96	1.35	58.04	1.047	1.25	13.49	......	Do.
25	6	2515	1	9.8	1.1	1.50	1.23	53.75	1.061	.92	8.98	5.32	Do.
Oct. 23	....	3196	1	9.0	1.3	2.00	1.64	58.37	1.069	.60	12.54	4.39	Dark green.
23	10	3203	2	9.0	1.0	2.93	2.33	57.63	1.077	.71	13.99	4.91	

* Not inverted.

TABLE No. 47.—SANFORD CORN. B. F. HATHEWAY, VERMONT.

July 28	1	249	3	5.5	0.9	4.46	1.90	59.18	1.037	1.90	4.64	2.52	Very dark green.
31	1	331	2	6.5	.8	2.37	1.49	49.63	1.048	1.56	7.01	3.31	Do.
Aug. 7	2	558	2	5.5	.8	1.65	.85	57.11	1.059	1.58	9.66	4.91	Do.
14	3	782	2	6.2	1.1	2.31	1.58	55.80	1.062	1.68	10.84	3.11	Do.
21	4	1047	2	6.1	.9	2.50	1.19	51.59	1.057	.87	9.73	3.92	Dark green, starchy.
28	5	1390	2	7.2	.9	2.00	1.01	46.30	1.064	.87	10.00	5.34	Do.
Sept. 4	6	1666	3	5.7	.9	2.11	1.43	32.87	1.062	.88	10.57	4.13	Do.
8	Y	1826	6	5.0	1.0	3.07	2.17	57.78	1.048	1.30	7.33	3.11	Dark green, some starch.
10	Y	1913	3	6.0	.9	1.76	1.08	55.91	1.047	1.25	7.38	2.59	Dark green, starchy.
11	6, 7	1924	6	6.6	.9	2.78	2.27	46.70	1.063	1.15	9.66	5.09	Dark green, some starch.
18	5	2114	5	6.0	.8	1.70	1.46	50.90	1.057	1.40	8.78	3.92	Dark green, starchy.
18	Z	2122	13	5.0	.9	5.72	4.46	47.16	1.058	.93	7.87	3.39	Do.

ANALYSES OF JUICES FROM CORNSTALKS—Continued.

TABLE No. 48.—MAMMOTH DENT, CHESTER COUNTY, PENNSYLVANIA. M. J. VARNEY, NORTH COLLINS, N. Y.

Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Remarks on juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*	*Pr. ct.*	
July 28	1	248	1	8.0	1.3	3.62	1.71	55.15	1.038	1.93	4.83	2.54	Very dark green.
31	1	330	2	7.2	1.0	4.75	2.35	54.95	1.041	2.27	5.49	2.47	Do.
Aug. 7	2	557	2	6.6	1.0	2.96	1.85	56.18	1.057	1.14	9.62	3.55	Dark green.
14	3	781	2	7.2	1.3	3.83	2.30	55.65	1.060	.97	9.25	4.50	Do.
21	4	1046	1	6.7	1.0	1.91	1.12	52.45	1.068	.64	11.84	4.33	Dark green, starchy.
28	5	1389	1	8.1	1.3	2.68	1.87	51.29	1.064	.96	11.03	4.41	Do.
Sept. 4	6	1665	1	6.5	1.2	1.63	1.07	45.68	1.072	.70	11.85	3.22	Do.
8	Y	1825	1	9.0	1.3	3.06	2.45	55.24	1.075	.53	12.80	5.27	Dark green, some starch.
10	Y	1912	2	6.0	1.0	2.72	2.04	66.26	1.041	.81	6.77	1.88	Dark green, starchy.
13	Y	1951	2	7.0	1.1	2.09	1.58	69.40	1.062	.74	10.50	4.11	Do.
18	7	2113	3	6.5	1.1	2.99	2.41	56.03	1.071	.64	11.94	5.11	Do.
18	Z	2121	1	7.3	1.2	1.18	1.03	60.30	1.041	.84	7.07	2.37	Do.
25	Z	2505	1	6.8	1.1	.95	.71	60.55	1.047	.99	7.45	2.97	Dark green, some starch.
25	Z	2506	1	6.5	1.2	1.56	1.02	50.00	1.041	1.49	6.41	2.33	Do.
25	Z	2507	1	6.3	1.0	1.25?	1.28	61.35	1.074	.74	12.60	5.05	Do.
25	Z	2508	1	6.3	1.0	1.21	.88	51.50	1.068	.61	13.88	2.17	Do.
25	Z	2509	1	7.0	1.2	1.89	1.55	53.96	1.066	.47	11.43	4.56	Do.
25	Z	2510	1	8.5	1.3	2.84	2.72	60.50	1.052	.65	8.86	4.28	Do.
25	8	2511	3	6.0	1.0	2.95	3.08?	39.71?	1.072	.69	11.02	6.15	Do.
Oct. 16	9	3072	5	5.8	1.0	3.58	3.36	48.19	1.066	1.14	11.06	4.73	Dark green.
16	11	3073	2	6.3	1.1	1.82	1.33	47.85	1.063	.97	9.51	1.66	Do.
23	....	3199	2	8.4	1.1	2.55	2.06	61.11	1.059	.68	9.58	6.17	Do.

TABLE No. 49.—EARLY MINNESOTA DENT. M. J. VARNEY, NORTH COLLINS, N. Y.

July 24	1	154	2	6.5	0.7	1.68	1.08	36.85	1.033	1.55	4.30	2.62	Light green, some starch.
27	1	236	2	6.0	.8	1.68	.99	40.29	1.055	.95	9.75	4.04	Very dark green.
24	2	153	2	6.5	.8	2.21	1.49	44.09	1.047	1.91	7.26	4.20?	Very dark green, starchy.
31	3	329	2	5.7	.7	1.79	.92	48.04	1.062	1.28	11.08	3.60	Dark green.
Aug. 7	4	556	2	5.8	.9	1.88	.80	44.66	1.070	.68	12.09	4.66	Dark green, watery, starchy.
14	5	780	2	5.9	.8	.82	.62	33.33	1.057	.68	7.95	5.47	Dark green.
17	2	907	1	5.0	.8	.81	.41	37.18	1.067	.91	11.05	4.35	Dark green, starchy.
21	6	1045	2	5.5	.8	.93	.66	42.61	1.057	1.21	8.51	4.75	Do.
28	7	1388	1	5.2	.8	.36	.20	20.64	1.067	1.76	10.69	5.08	Do.
Sept. 4	6	1667	3	6.0	.8	1.43	.80	56.16	1.064	.73	10.84	4.88	Do.
8	Y	1824	4	6.0	.9	1.64	1.28	43.46	1.060	.94	9.70	4.27	Dark green, some starch.
10	Y	1911	5	6.0	.9	1.43	1.19	37.03	1.055	1.36	7.49	4.08	Dark green, starchy.
11	7	1923	2	5.0	.9	.86	.75	39.47	1.076	.68	11.45	6.18	Dark green, some starch.
13	Y	1950	6	6.0	.8	1.92	1.47	42.15	1.063	.79	9.97	4.52	Dark green, starchy.
18	Z	2120	16	5.6	.9	3.94	2.66	25.04	1.074	1.22	9.78	7.16	Do.

ANALYSES OF JUICES FROM SORGHUM.

A few additional examinations have been made of canes received from experimenters outside the Department grounds.

The canes were in some cases delayed, and did not reach the Department in very good condition, being withered or partially fermented.

TABLE No. 50.

SAMPLES OF SORGHUM CANES RECEIVED FROM ABROAD.

Contributor.	Date.	Development.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.
					Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*	
J. H. Strider, Halltown, W. Va.....	Sept. 28	....	2653	6	7.0	.8	......	5.87	64.10	1.071
D. M. Nesbit, College Station, Md..	Sept. 23	....	2355	1	6.0	1.0	......	1.11	68.10	1.069
F. Y. Braendle, Arlington, Va......	Sept. 17	14	2067	6	8.8	.8	10.30	8.12	56.09	1.071
E. Lawford, Sandy Springs, Md....	Sept. 28	....	2592	4	6.8	.8	......	3.35	60.77	1.076
D. M. Nesbit, College Station, Md..	Sept. 17	11	2105	2	8.3	.6	1.61	1.36	66.45	1.054
E. Lawford, Sandy Springs, Md....	Oct. 8	....	2784	4	9.2	.6	3.46	2.85	64.37	1.082
Do..........do........do	Oct. 16	16	3001	6	9.1	.7	2.86	2.41	56.52	1.667
Do..........do........do	Sept. 13	9-10-11	1952	6	8.5	.6	5.89	4.71	64.43	1.073
Prof. J. W. Sanborn, Hanover, N. H.	Sept. 22	9	2301	4	9.0	.9	6.10	4.91	64.48	1.055
John Hufbauer, El Paso, Kans....	Oct. 8	....	2859	1	10.0	1.0	1.54	1.31	63.63	1.069
D. M. Nesbit, College Station, Md..	Sept. 8	5-9	1851	4	8.4	.7	3.23	2.76	69.08	1.053
In s Stuart, New York, N. Y.....	Oct. 15	....	3042	...	.....	....	......	.42	62.11	1.056
N. M. Curtiss, Ogdensburgh, N. Y..	Aug. 26	....	1289	12	5.5	.9	......	5.90	53.20	1.052
D. M. Nesbit, College Station, Md..	Sept. 17	9	2106	2	7.5	.7	1.41	1.20	65.63	1.045
F. Y. Braendle, Arlington, Va......	Sept. 17	....	2068	3	10.0	1.2	6.67	4.47	59.83	1.035
N. M. Curtiss, Ogdensburgh, N. Y..	Aug. 26	1-3	1290	10	7.3	.8	......	6.67	67.35	1.037
Prof. J. W. Sanborn, Hanover, N. H.	Sept. 10	3	1916	4	10.0	.9	5.38	4.41	67.39	1.038

Contributor.	Date.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Exponent.	Available sucrose in juice.	Remarks on juice.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*		*Pr. ct.*	
J. H. Strider, Halltown, W. Va.....	Sept. 28	2.38	13.19	1.84	75.76	9.99	Dark green, somewhat starchy.
D. M. Nesbit, College Station, Md..	Sept. 23	1.87	12.72	2.53	74.30	9.45	......do ....
F. Y. Braendle, Arlington, Va......	Sept. 17	1.35	12.52	3.40	72.50	9.08	....
E. Lawford, Sandy Springs, Md....	Sept. 28	6.78	9.88	2.03	52.86	5.23	Thin and watery......
D. M. Nesbit, College Station, Md..	Sept. 17	2.96	9.24	1.75	66.24	6.12	Dark green, starchy..
E. Lawford, Sandy Springs, Md....	Oct. 8	8.42	9.23	2.40	46.03	4.25	......do ....
Do..........do........do	Oct. 16	5.10	9.03	2.60	53.97	4.87	Dark green ....
Do..........do........do	Sept. 13	3.87	8.70	5.00	49.52	4.31	Light green, starchy..
Prof. J. W. Sanborn, Hanover, N. H.	Sept. 22	4.33	8.51	1.37	59.47	5.09	Dark green, somewhat starchy.
John Hufbauer, El Paso, Kans.....	Oct. 8	7.71	7.34	1.88	43.35	3.18	....
D. M. Nesbit, College Station, Md..	Sept. 8	3.28	6.41	3.65	48.05	3.06	Dark green, starchy..
Inglis Stuart, New York, N. Y.....	Oct. 15	5.68	6.30	1.51	46.70	2.94	Dark green ....
N. M. Curtiss, Ogdensburgh, N. Y..	Aug. 26	5.17	6.15	1.66	47.38	2.91	Dark green, starchy..
D. M. Nesbit, College Station, Md..	Sept. 17	3.77	5.99	1.92	51.28	3.07	......do ....
F. Y. Braendle, Arlington, Va......	Sept. 17	4.02	3.96	1.10	43.61	1.73	......do ....
N. M. Curtiss, Ogdensburgh, N. Y..	Aug. 26	5.36	3.26	1.02	33.32	1.10	....
Prof. J. W. Sanborn, Hanover, N. H.	Sept. 10	5.37	3.26	.77	84.68	1.13	Dark green, starchy.

ANALYSES OF JUICES FROM CORN STALKS.

SAMPLES OF CORNSTALKS SENT IN FROM ABROAD.

Contributor.	Date.	Number of analysis.	Number of stalks.	Length.	Diameter at butt.	Total weight.	Stripped weight.	Juice expressed.	Specific gravity of juice.
				Ft.	*In.*	*Lbs.*	*Lbs.*	*Pr. ct.*	
F. Y. Braendle, Arlington, Va	Sept. 29	2680	2	......	1. 3	......	1. 82	42. 78	1. 018
Do.............do	Sept. 29	2676	1	4. 9	1. 2	......	. 89	60. 34	1. 019
Do.............do	Sept. 29	2677	1	5. 6	1. 3	......	1. 76	62. 04	1. 014
Do.............do	Sept. 29	2678	1	......	1. 2	......	1. 03	52. 36	1. 010
Do.............do	Sept. 29	2679	1	......	1. 2	......	1. 28	60. 34	1. 012

Contributor.	Date.	Glucose in juice.	Sucrose in juice.	Solids not sugar in juice.	Exponent.	Available sucrose in juice.	Remarks on juice.
		Pr. ct.	*Pr. ct.*	*Pr. ct.*		*Pr. ct.*	
F. Y. Braendle, Arlington, Va	Sept. 29	1. 20	2. 87	1. 23	54. 15	1. 55	Brown
Do.............do	Sept. 29	2. 21	2. 31	. 78	43. 58	1. 00	....do
Do.............do	Sept. 29	2. 29	1. 12	. 63	27. 72	. 30	....do
Do.............do	Sept. 29	. 93	. 98	1. 01	33. 56	. 83	....do
Do.............do	Sept. 29	1. 24	. 94	1. 08	28. 83	. 27	....do

AVERAGES OF EACH STAGE OF EACH VARIETY.

TABLE No. 51.—EARLY AMBER. D. SMITH, ARLINGTON, VA.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
				Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*
1	July 12	June 25	1	4. 71	. 60	. 99	6. 30	9. 52	. 06	36. 27
2	July 13	June 29	1	3. 77	2. 25	1. 72	7. 74	29. 07	. 65	52. 30
3	July 15	July 3, 6	1	3. 66	5. 53	. 91	10. 10	54. 75	3. 03	46. 99
4	July 16	July 12, 16	1	3. 62	4. 91	. 95	9. 48	51. 79	2. 54	54. 73
5	July 17	July 9	1	3. 10	7. 81	1. 83	12. 74	61. 30	4. 79	43. 97
6	July 20	July 12	1	2. 78	9. 55	2. 03	14. 36	66. 50	6. 35	44. 13
7	July 22	July 15	2	2. 26	9. 60	2. 86	14. 72	65. 22	6. 26	49. 38
8	July 23	July 18	1	2. 87	10. 74	2. 15	15. 76	68. 15	7. 32	61. 83
9	....	July 21	4	2. 49	11. 20	2. 22	15. 91	70. 40	7. 88	......
10	July 28	July 24	8	2. 04	12. 08	2. 26	16. 38	73. 75	8 91	65. 28
11	August 4	July 28	6	1. 45	13. 80	3. 06	18. 31	75. 37	10. 40	62. 99
12	August 11	August 1	11	1. 19	14. 06	3. 02	18. 27	76. 96	10. 82	61. 95
13	August 20	August 7	10	1. 23	12. 69	2. 82	16. 74	75. 82	9. 62	59. 77
14	September 5	August 14	10	1. 15	12. 62	3. 39	17. 16	73. 54	9. 28	55. 24
15	September 10	August 22	14	1. 52	10. 62	3. 37	15. 51	68. 47	7. 27	57. 34
16	September 28	August 31	10	1. 50	11. 10	3. 00	15. 60	71. 15	7. 90	60. 35
17	October 20	....	7	1. 39	13. 63	3. 69	18. 71	72. 85	9. 93	57. 26
18	October 28	....	9	1. 78	10. 50	4. 02	16. 30	64. 42	6. 76	57. 27

AVERAGES OF EACH STAGE OF EACH VARIETY—Continued.

TABLE No. 52.—EARLY AMBER. PLANT SEED CO., ST. LOUIS, MO.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
				Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*
1	July 12	June 25	1	4.04	.98	.91	5.93	16.53	.16	62.78
2	July 18	June 20	2	3.54	5.45	1.86	10.85	50.23	2.74	43.31
3	July 16	July 3, 6	1	4.01	......	1.40	7.14	24.23	......	54.09
4	July 17	July 12, 16	1	2.68	7.95	2.14	12.77	62.26	4.95	50.87
5	July 20	July 9	1	3.05	6.44	1.80	11.29	57.04	3.67	64.79
6	July 20	July 12	1	3.13	6.97	1.72	11.82	58.97	4.11	52.46
7	July 21	July 15	1	2.64	10.02	2.19	14.85	67.48	6.76	51.23
8	July 23	July 18	1	2.87	9.36	1.78	14.01	66.81	6.25	58.81
9	......	July 21	4	2.58	10.48	2.21	15.27	68.63	7.19	......
10	July 29	July 24	5	1.94	12.02	2.53	16.49	72.89	8.76	62.51
11	August 4	July 28	6	1.55	13.35	3.45	18.35	72.75	9.71	64.65
12	August 15	August 1	9	1.46	13.84	3.14	18.44	75.05	10.39	62.24
13	August 17	August 7	5	1.20	12.75	2.41	16.36	77.93	9.94	63.78
14	August 22	August 14	15	1.47	11.74	2.88	16.09	72.96	8.57	60.39
15	September 17	August 22	16	1.51	10.70	3.85	16.06	67.00	7.17	57.22
16	September 16	August 31	9	1.70	8.84	3.45	13.99	63.19	5.59	57.34
17	October 8	......	5	1.25	12.79	3.72	17.76	72.02	9.21	62.70
18	October 31	......	15	2.04	10.13	3.76	15.93	63.59	6.44	56.96

TABLE No. 53.—EARLY GOLDEN. A. B. SWAIN, ELYSIAN, MINN.

1	July 12	July 1	1	3.68	.70	.77	5.15	13.59	.10	63.90
2	July 15	July 5, 9	1	3.83	2.08	5.68	11.59	17.95	.37	40.82
3	July 16	July 7, 12	1	4.09	2.34	1.22	7.65	30.59	.72	48.04
4	July 17	July 12, 16	1	3.05	6.43	1.86	11.34	56.70	3.65	52.10
5	July 20	July 15	1	3.10	7.03	1.64	11.77	59.73	4.20	58.27
6	July 20	July 18	1	3.04	7.63	1.44	12.11	63.01	4.81	54.95
7	July 23	July 21	1	2.81	9.34	2.28	14.43	64.73	6.05	47.02
8	July 26	July 24	1	2.52	11.77	1.89	16.18	72.74	8.56	62.00
9	July 27	July 27, 30	1	2.04	11.09	2.92	16.05	69.10	7.66	60.79
10	July 29	July 28	2	1.75	11.09	2.52	15.36	72.20	8.01	51.56
11	July 31	August 2	1	1.66	12.27	3.89	17.82	68.86	8.45	63.28
12	August 7	August 6, 10	12	1.46	13.65	3.22	18.33	74.47	10.27	65.16
13	August 27	August 7	15	1.40	12.33	2.93	16.66	74.01	9.13	61.69
14	September 7	August 14	18	1.54	11.01	3.29	15.84	69.50	7.65	60.27
15	September 8	August 20	10	1.72	8.97	3.05	13.74	65.28	5.86	58.36
16	October 5	August 26	11	2.05	9.02	3.91	14.98	62.14	5.61	56.51
17	October 29	......	5	1.41	13.50	3.31	18.22	74.10	10.00	60.72
18	November 5	......	7	2.21	10.41	2.83	15.45	67.38	7.01	60.22

TABLE No. 54.—GOLDEN SIRUP. W. H. LYTLE, YELLOW SPRINGS, OHIO.

1	July 12	July 2	1	3.59	.48	.87	4.94	9.72	.05	65.32
2	July 16	July 7, 12	1	3.81	2.22	3.09	9.12	24.34	.54	48.07
3	July 17	July 16	1	4.05	3.61	1.87	9.53	37.88	1.37	53.55
4	July 19	July 12, 16	1	3.97	5.28	1.41	10.66	49.53	2.62	44.12
5	July 20	July 19	1	3.81	5.38	1.83	11.02	48.82	2.63	62.71
6	July 21	July 22	1	2.34	7.37	2.24	11.95	61.68	4.55	59.01
7	July 23	July 23	1	2.75	8.83	1.85	13.43	65.75	5.81	59.39
8	July 23	July 25	1	2.99	8.33	2.17	13.49	61.75	5.14	56.41
9	July 26	July 28	1	3.44	8.61	1.88	13.93	61.81	5.32	64.14
10	August 10	August 31	16	1.83	11.57	2.68	16.08	71.95	8.32	64.13
11	August 10	August 3	11	1.60	12.92	2.92	17.44	74.08	9.57	61.57
12	August 27	August 6, 10	7	1.18	13.74	3.21	18.13	75.78	10.41	61.75
13	September 4	August 7, 14	2	.87	15.30	2.95	19.12	80.02	12.24	59.28
14	August 31	August 15	9	1.42	11.44	3.07	15.93	71.81	8.22	60.71
15	September 14	August 22	13	1.54	10.62	2.81	14.97	70.93	7.53	58.86
16	October 2	August 30	9	1.52	11.78	3.30	16.60	70.96	8.36	60.24
17	October 21	......	6	1.61	12.52	[illegible].95	18.08	69.25	8.67	58.29
18	November 5	......	6	2.10	9.24	3.25	14.59	63.33	5.85	58.82

AVERAGES OF EACH STAGE OF EACH VARIETY—Continued.

TABLE NO. 55.—WHITE LIBERIAN. D. SMITH, ARLINGTON, VA.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
				Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*
1	July 12	July 3	1	3.28	1.19	.79	5.26	22.62	.27	46.57
2	July 16	July 8, 12	1	3.81	2.45	.87	7.13	34.36	.84	47.09
3	July 17	July 7, 12, 16	1	3.68	2.35	2.05	8.08	29.08	.68	51.53
4	July 17	July 15	1	3.21	3.70	1.72	8.63	42.87	1.59	42.28
5	July 21	July 16	1	3.58	5.11	1.62	10.31	49.56	2.53	43.87
6	July 21	July 17	1	3.16	7.20	2.03	12.39	58.11	4.18	57.00
7	July 23	July 19	1	3.30	6.30	1.98	11.58	54.40	3.43	63.20
8	July 26	July 21	1	2.99	8.46	1.63	13.08	64.68	5.46	64.84
9	July 27	July 24	1	2.94	8.93	2.03	13.90	64.24	5.74	41.60
10	August 6	July 27	5	2.28	10.80	2.73	15.81	68.31	7.38	63.90
11	August 15	August 1	8	1.77	12.11	2.84	16.72	72.43	8.77	66.75
12	August 9	August 7	7	1.63	12.81	3.16	17.60	72.78	9.32	67.09
13	August 21	August 14	6	1.27	13.10	2.92	17.29	75.77	9.93	63.94
14	August 19	August 21, 28	3	1.02	14.37	2.85	18.24	78.78	11.32	64.19
15	September 2	August 28, Sept. 4	6	1.13	13.69	2.84	17.66	77.52	10.61	64.16
16	September 25	September 4	6	1.21	12.88	3.07	17.16	75.06	9.67	58.36
17	November 3		3	1.16	15.05	4.54	20.75	72.53	10.92	62.24
18	November 10		5	1.87	10.41	3.16	15.44	67.42	7.02	63.46

TABLE NO. 56.—EARLY AMBER. S. E. EVANS, MONROE, KANS.

1	July 15	July 3	1	4.22	.60	.49	5.31	11.30	.07	51.28
2	July 16	July 8	1	4.38	1.39	1.51	7.28	19.09	.27	52.67
3	July 20	July 12	1	4.60	3.71	2.48	10.79	34.38	1.28	62.13
4	July 22	July 16	2	4.43	3.40	1.38	9.21	36.92	1.60	59.85
5	July 22	July 20	1	4.13	5.50	2.04	11.67	47.13	2.59	57.05
6	July 22	July 24	1	3.76	6.67	2.20	12.63	52.81	3.52	52.77
7	July 24	July 27	1	3.19	5.91	1.51	10.61	55.70	3.29	67.72
8	July 26	July 29	1	2.85	8.82	1.41	13.08	67.43	5.95	50.80
9	July 28	July 31	4	3.15	8.32	2.19	13.66	60.91	5.07	65.50
10	August 10	August 1	6	2.36	10.74	2.83	15.93	67.42	7.23	64.09
11	August 9	August 2	1	1.83	12.84	3.07	17.74	72.38	9.29	62.61
12	August 18	August 4	3	1.57	13.16	2.89	17.62	74.69	9.83	59.51
13	September 19	August 7	8	1.31	11.72	3.16	16.19	72.39	8.48	58.23
14	September 1	August 14	2	1.38	12.68	3.86	17.92	70.76	8.97	59.98
15	October 1	August 28	5	1.50	13.16	3.42	18.08	72.79	9.58	57.00
16	October 13	September 15	3	1.12	15.32	3.13	19.57	78.28	11.99	56.39
17	November 5		2	2.04	13.60	3.43	19.07	71.32	9.70	59.45

TABLE NO. 57.—BLACK TOP. D. W. AIKEN, COKESBURY, S. C.

1	July 17	July 6, 10	1	2.92	3.88	1.52	8.32	46.63	1.81	47.07
2	July 17	July 8, 12	1	2.01	3.23	1.81	7.05	45.82	1.49	52.87
3	July 20	July 13	1	3.88	4.31	1.80	9.99	43.14	1.86	44.39
4	July 22	July 16	1	1.83	4.84	1.98	8.65	55.95	2.71	54.93
5	July 22	July 18	1	3.00	5.35	2.29	10.64	50.28	2.69	46.79
6	July 22	July 20	1	2.01	5.82	1.84	9.67	60.19	3.50	62.65
7	July 23	July 23	1	2.06	7.90	2.11	12.07	65.45	5.17	66.49
8	July 26	July 26	1	1.97	7.78	1.48	11.23	69.28	5.39	59.90
9	July 31	July 31	7	1.66	10.21	2.54	14.41	70.85	7.23	61.91
10	August 12	August 7	4	1.24	11.67	2.81	15.72	74.24	8.66	64.46
11	August 19	August 14	2	.79	13.49	4.08	18.36	73.48	9.91	59.73
12	August 23	August 21, 28	2	.77	13.58	3.33	17.68	76.81	10.43	63.54
13	August 26	August 21, 28	2	.84	13.89	2.40	17.13	81.09	11.26	61.03
14	August 31	September 4	1	.93	12.79	3.67	17.39	73.55	9.41	63.72
15	September 9	September 14	6	.98	12.27	3.30	16.55	74.26	9.11	59.49
16	September 29	September 29	7	1.16	12.58	2.59	16.33	77.04	9.77	58.97
17	October 17		3	.51	14.78	4.35	19.64	75.26	11.12	59.98
18	October 26		1	3.17	11.59	1.58	16.34	70.93	8.22	60.68

AVERAGES OF EACH STAGE OF EACH VARIETY—Continued.

TABLE NO. 58.—AFRICAN. W. E. PARKS, CARLISLE, KY.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.
1	July 17	July 2	1	2.92	2.98	1.53	7.43	40.11	1.20	58.49
2	July 17	July 7, 12	1	4.25	1.76	1.84	7.85	22.42	.39	51.74
3	July 19	July 16	1	4.67	1.73	1.34	7.74	22.35	.39	38.15
4	July 21	July 12, 16	1	3.28	1.87	1.71	6.86	27.26	.51	49.79
5	July 24	July 19	2	4.38	3.84	1.66	9.88	38.87	1.49	56.76
6	July 21	July 22	1	3.62	5.66	1.97	11.25	50.31	2.85	47.45
7	July 23	July 25	1	3.85	4.67	1.52	10.04	46.51	2.17	52.63
8	July 26	July 28	1	2.67	8.96	2.32	13.95	64.23	5.76	56.62
9	August 5	July 31	10	1.49	11.32	2.55	15.36	73.70	8.34	64.21
10	August 3	August 7	6	2.40	8.76	2.90	14.06	62.30	5.46	63.09
11	August 14	August 14, 21	9	1.24	12.31	3.02	16.57	74.29	9.15	63.44
12	August 21	August 14, 21	4	2.26	10.52	2.89	15.67	67.14	7.06	63.43
13	August 24	August 28	4	1.85	11.02	2.83	15.70	70.19	7.73	65.94
14	August 27	September 4	4	1.44	11.80	3.76	17.00	69.41	8.19	65.56
15	September 3	September 12	8	1.68	10.56	3.05	15.29	69.07	7.29	59.93
16	September 24	September 22	24	.98	13.03	3.33	17.34	75.09	9.78	61.73
17	October 22		8	1.58	13.67	3.97	19.22	71.12	9.69	59.27
18	November 7		6	1.67	12.01	3.13	16.81	71.44	8.58	62.59

TABLE NO. 59. AMOS CARPENTER, CARPENTER'S STORE P. O., MO.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
1	August 2	August 2	1	2.95	3.05	2.10	8.10	37.65	1.15	70.98
2	August 4	August 4	2	2.92	3.73	1.74	8.39	44.46	1.66	72.28
3	August 9	August 7	1	2.68	6.13	2.23	11.04	55.53	3.40	69.84
4	August 18	August 10	4	3.13	7.07	2.02	12.22	67.86	4.09	67.44
5		August 14	2	2.78	7.80	2.04	12.62	61.81	4.82	
6		August 17	4	2.72	8.07	2.00	12.79	63.10	5.09	
7	August 23	August 21	4	2.88	9.46	1.84	14.18	66.71	6.31	68.00
8	August 26	August 28	2	2.29	9.15	2.04	13.48	67.88	6.21	69.43
9	August 26	September 1	2	1.95	9.88	2.30	14.13	69.92	6.91	68.07
10	September 3	September 4	4	1.64	11.28	2.58	15.50	72.77	8.21	68.25
11	September 8	September 9	4	1.46	12.37	2.90	16.73	73.94	9.15	57.02
12	September 18	September 15	4	1.14	12.28	4.50	17.92	68.53	8.42	61.82
13	September 27	September 22	6	.92	13.94	3.25	18.11	76.97	10.73	61.16
14	September 28	September 29	5	1.09	15.11	3.74	19.94	75.78	11.45	62.25
15	October 8	October 8	5	1.10	14.70	4.17	19.97	73.61	10.82	62.64
16	October 21	October 21	2	1.19	15.06	3.13	19.38	77.71	11.70	62.53
17	November 5		2	.86	13.76	3.31	17.93	76.69	10.55	62.84

TABLE NO. 60.—OOMSEEANA. BLYMYER & CO., CINCINNATI, OHIO.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
1	July 15	July 7, 12	1	2.84	1.55	2.30	6.69	23.17	.36	31.60
2	July 15	July 8, 12	1	4.82	1.46	.99	7.27	20.08	.29	51.83
3	July 20	July 16	1	2.85	2.26	1.79	6.90	32.75	.74	58.60
4	July 21	July 19	1	3.03	2.71	1.98	7.72	35.10	.95	57.10
5	July 21	July 22	1	2.57	4.33	1.84	8.74	49.54	2.15	42.80
6	July 23	July 24	2	2.95	4.26	1.90	9.11	46.76	1.99	65.30
7	July 23	July 27	2	3.68	3.27	2.04	8.99	36.37	1.19	61.23
8	July 23	August 1, 7	1	2.11	6.29	2.02	10.42	60.36	3.80	58.88
9	August 2	July 31, August 7	4	3.18	6.48	2.37	12.03	53.86	3.49	64.67
10	August 8	August 14, 21	22	2.29	8.20	2.32	12.81	64.01	5.25	66.42
11	August 20	August 14, 21, 28	4	1.72	9.49	2.64	13.85	68.52	6.50	68.59
12	August 24	August 28	4	1.69	12.42	2.47	16.58	74.91	9.30	66.53
13	August 26	September 4	4	1.65	11.43	2.88	15.96	71.62	8.19	65.34
14	September 3	September 11	8	1.52	11.31	2.77	15.60	70.52	7.98	62.61
15	September 13	September 18	7	1.42	12.13	2.71	16.26	74.60	9.05	63.50
16	September 28	September 25	16	.92	12.92	3.55	17.39	74.30	9.60	63.07
17	October 20		6	2.06	11.59	2.88	16.53	70.12	8.13	63.69
18	November 3		9	1.20	13.29	4.25	18.74	70.92	9.42	64.31

AVERAGES OF EACH STAGE OF EACH VARIETY—Continued.

TABLE No. 61.—REGULAR SORGHO. BLYMYER & Co., CINCINNATI, OHIO.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.
1	July 19	July 12	1	4.76	1.07	2.66	8.49	12.60	.13	45.48
2	July 20	July 14	1	2.97	3.18	1.39	7.54	42.19	1.34	57.10
3	July 23	July 16	1	4.27	2.53	2.24	9.04	27.99	.71	53.46
4	July 23	July 19	1	4.55	2.18	1.59	8.32	26.20	.57	50.58
5	July 23	July 22	1	3.75	4.62	1.95	10.32	44.77	2.07	46.25
6	July 23	July 25	1	3.45	5.55	2.40	11.40	48.68	2.70	56.74
7	July 28	July 28	2	3.64	7.03	.57	11.24	62.55	4.40	60.54
8	July 29	July 31	1	3.64	6.37	2.69	12.70	50.16	3.19	63.70
9	August 7	August 7	13	2.51	9.79	2.56	14.86	65.88	6.45	62.08
10	August 13	August 7, 14, 21	6	2.18	11.15	2.36	15.69	71.06	7.92	64.51
11	August 23	August 21	8	1.89	10.24	2.45	14.58	70.23	8.71	64.44
12	August 27	August 28	4	1.39	10.80	3.06	15.25	70.82	7.65	60.00
13	August 31	September 4	8	1.33	11.53	3.05	15.91	72.47	8.36	59.14
14	September 2	September 11	8	1.28	12.67	3.20	17.15	73.88	9.36	59.14
15	September 9	September 18	4	1.41	11.77	2.58	15.76	74.68	8.79	62.72
16	September 26	September 26	20	1.18	12.52	3.19	16.89	74.13	9.28	59.44
17	October 23		8	1.38	13.28	4.10	18.76	70.79	9.40	58.06
18	November 9		5	1.34	12.11	3.29	16.74	72.34	8.86	59.52

TABLE No. 62.—HYBRID. E. LINK, GREENEVILLE, TENN.

1	July 24	July 16	1	2.85	3.17	2.32	8.34	38.01	1.20	56.00
2	July 24	July 21	1	3.06	3.67	2.18	8.91	41.22	1.51	56.90
3	July 26	July 26	1	2.88	5.48	2.06	10.42	52.59	2.88	59.25
4	July 29	July 31	2	2.76	6.25	2.29	11.30	55.31	3.46	63.55
5	August 1	August 3	2	2.60	6.61	2.75	11.96	55.28	3.65	67.44
6	August 3	August 6	1	2.82	9.23	2.14	14.19	65.05	6.00	65.42
7	August 5	August 8, 11	1	2.43	8.55	3.86	14.84	57.69	4.93	64.93
8	August 9	August 7, 14	1	1.68	10.42	3.12	15.22	68.46	7.13	79.39
9	August 17	August 14	3	1.72	11.60	2.89	16.21	71.56	8.30	65.10
10	August 19	August 21	2	1.16	13.88	3.15	18.19	76.31	10.49	63.16
11	August 25	August 28	4	1.17	13.30	3.30	17.77	74.85	9.96	62.44
12	August 26	August 31	2	1.07	13.64	2.97	17.68	77.15	10.52	64.78
13	September 1	September 4	4	1.05	14.20	3.49	18.74	75.77	10.76	64.64
14	September 8	September 11	1	.85	14.28	3.38	18.51	77.15	11.02	65.01
15	September 15	September 19	2	.72	15.21	3.39	19.32	78.73	11.97	61.51
16	September 28	September 28	6	.63	14.99	3.60	20.22	74.13	11.11	61.63
17	October 25		4	.46	16.14	4.57	21.17	76.24	12.31	62.40
18	October 27		2	.50	15.15	3.55	19.20	78.91	11.95	64.63

TABLE No. 63.—SUGAR CANE. J. W. BARGER, LOVILIA, IOWA.

1	July 20	July 16	1	4.94	1.55	1.65	8.14	19.04	.30	68.75
2	July 20	July 20	1	5.61	1.93	1.51	9.05	21.33	.41	61.21
3	July 21	July 23	1	5.19	1.80	2.13	9.12	19.74	.36	54.10
4	July 21	July 26	1	5.13	3.33	2.00	10.46	31.84	1.06	59.35
5	July 22	July 28	1	4.69	3.81	1.96	10.46	36.42	1.39	53.61
6	July 24	July 30	1	5.13	3.85	2.15	11.13	34.59	1.30	51.56
7	July 27	August 2, 7	1	4.58	5.65	2.95	13.18	42.87	2.42	64.29
8	July 29	July 31, August 14	1	4.62	6.27	3.03	13.92	45.04	2.82	67.90
9	August 3	August 7, 14	6	4.15	10.11	2.85	17.11	59.09	5.97	66.18
10	August 17	August 21	3	2.10	12.09	2.95	17.14	70.54	8.53	64.26
11	August 23	August 23	2	1.98	13.97	3.18	19.13	73.03	10.20	63.33
12	August 27	August 25	4	1.74	13.01	3.72	18.47	70.44	9.16	62.25
13	September 3	August 28	2	1.46	13.86	3.19	18.51	74.88	10.38	60.26
14	September 8	September 4	2	1.35	14.16	2.77	18.28	77.46	10.97	62.13
15	September 15	September 14	2	1.33	14.72	2.86	18.91	77.84	11.46	62.22
16	September 28	September 28	6	1.26	13.54	3.20	18.00	75.22	10.18	61.33
17	October 20		3	1.17	14.54	4.49	20.20	71.98	10.47	63.15
18	November 1		4	1.05	14.49	3.47	19.01	76.22	11.04	61.99

AVERAGES OF EACH STAGE OF EACH VARIETY—Continued.

TABLE NO. 64.—OOMSEEANA. D. W. AIKEN, COKESBURY, S. C.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.
1	July 24	July 24	1	3.16	5.15	2.12	10.43	49.38	2.54	58.38
2	July 26	July 31	2	2.73	4.62	2.28	9.63	47.98	2.22	62.46
3	July 26	August 2	1	2.87	6.86	2.02	11.75	58.38	4.00	56.33
4	July 27	August 3	1	2.72	6.69	2.98	12.39	54.00	3.61	58.44
5	July 30	August 4	3	2.70	7.05	2.20	11.95	59.00	4.16	66.39
6	August 1	August 5	2	2.41	9.32	2.77	14.50	63.59	5.93	66.14
7	August 5	August 7	1	2.17	9.42	2.87	14.46	65.15	6.14	66.30
8	August 5	August 12	1	2.17	10.58	3.49	16.24	65.15	6.89	64.00
9	August 14	August 14, 17, 21	3	1.24	11.55	3.04	15.83	72.96	8.43	65.66
10	August 22	August 23	6	1.71	10.04	2.83	14.58	68.86	6.91	65.97
11	August 27	August 28	2	1.64	11.15	3.08	15.87	70.26	7.83	62.85
12	September 1	August 31	4	1.35	11.79	3.38	16.52	71.37	8.41	61.45
13	September 7	September 4	1	1.02	11.91	2.61	15.54	76.64	9.13	65.19
14	September 15	September 10	2	1.12	13.28	2.79	17.19	77.25	10.26	64.92
15	September 22	September 17	2	.84	15.07	2.92	18.83	80.03	12.06	58.77
16	September 28	September 25	8	.68	14.78	3.67	19.13	77.26	11.42	57.81
17	October 20		4	.63	15.54	5.31	21.48	72.35	11.24	61.72
18	November 9		2	.97	13.26	3.42	17.65	75.13	9.96	56.10

TABLE NO. 65.—NEEAZANA. W. H. LYTLE, YELLOW SPRINGS, OHIO.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
1	July 17	July 12	1	4.95	1.13	1.86	7.94	14.23	.16	60.05
2	July 19	July 16	1	5.26	1.81	1.45	8.52	21.24	.38	56.23
3	July 23	July 20	1	4.80	3.22	2.62	10.64	30.26	.97	57.43
4	July 23	July 24	2	5.02	3.37	1.88	10.27	32.81	1.11	58.91
5	July 23	July 28	1	4.91	6.08	1.90	12.89	47.17	2.87	54.77
6	July 26	July 31	1	5.40	6.20	1.97	13.57	45.69	2.83	55.06
7	July 27	August 4	1	4.62	5.66	1.98	12.26	46.17	2.61	60.31
8	July 30	August 8, 14	2	4.32	6.66	2.41	13.39	49.74	3.31	61.46
9	August 6	August 7, 21	17	3.77	9.20	2.49	15.46	59.51	5.47	65.12
10	August 15	August 14, 21	8	2.94	11.11	2.84	16.89	65.78	7.31	63.89
11	August 20	August 28	8	2.52	11.32	3.00	16.84	67.22	7.61	65.47
12	August 28	September 4	8	2.61	11.93	2.73	17.27	69.08	8.24	63.52
13	August 31	September 11	8	2.47	12.15	3.01	17.63	68.92	8.37	61.33
14	September 7	September 18	4	2.18	11.73	2.15	16.06	73.04	8.57	61.71
15	September 18	September 25	8	1.99	13.06	2.87	17.92	72.88	9.52	61.15
16	October 1	October 1	12	1.86	13.62	3.27	18.75	72.64	9.89	61.25
17	October 21		7	1.66	14.22	4.55	20.43	69.60	9.90	59.20
18	November 4		7	1.94	13.15	3.05	18.14	72.49	9.53	64.57

TABLE NO. 66.—GOOSE NECK. P. P. RAMSEY, BELGRADE, MO.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
1	July 17	July 12	1	3.85	1.02	1.73	6.60	15.45	.16	60.49
2	July 19	July 14	1	4.31	1.56	1.52	7.39	21.11	.33	58.06
3	July 20	July 16	1	4.47	1.03	1.50	7.00	14.71	.15	52.75
4	July 22	July 18	1	5.07	2.16	1.84	9.07	23.81	.51	78.30
5	July 24	July 21	3	3.45	4.01	2.36	9.82	40.84	1.64	56.56
6	July 26	July 24	1	4.32	4.16	1.89	10.37	40.12	1.67	64.86
7	July 27	July 28	1	4.55	4.28	2.47	11.30	37.88	1.62	65.92
8	July 28	August 2, 7	1	4.10	4.83	2.13	11.06	43.67	2.11	63.90
9	August 9	July 31, August 7	23	2.91	8.94	2.28	14.13	63.27	5.66	66.45
10	August 20	August 14	4	1.71	10.35	3.05	15.11	68.50	7.09	64.78
11	August 24	August 21, 24, 28	4	1.80	11.43	2.32	15.55	73.51	8.40	65.93
12	August 26	September 4	4	1.91	10.48	2.63	15.02	69.77	7.31	65.51
13	September 1	September 13	4	1.62	11.09	3.02	15.73	70.50	7.82	65.26
14	September 3	September 20	3	1.37	12.40	2.32	16.09	77.07	9.56	63.06
15	September 16	September 27	12	1.31	12.42	2.80	16.53	75.14	9.33	57.87
16	September 30	October 4	12	1.24	13.31	3.64	18.19	72.07	9.59	59.92
17	October 19		5	.96	14.72	4.23	19.91	74.94	11.03	57.32
18	November 4		9	1.89	12.01	3.51	17.41	68.98	8.28	62.19

AVERAGES OF EACH STAGE OF EACH VARIETY—Continued.

TABLE No. 67.—EARLY ORANGE. I. A. HEDGES, SAINT LOUIS, MO.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.
1	July 19	July 12	1	5.09	1.39	1.56	8.04	17.29	.24	60.18
2	July 20	July 16	1	4.83	2.98	1.76	9.57	31.14	.93	58.57
3	July 21	July 20	1	5.32	3.19	1.59	10.10	31.58	1.01	50.52
4	July 21	July 23	1	5.24	3.16	1.57	9.97	31.61	1.00	51.08
5	July 23	July 26	1	4.94	4.46	1.81	11.21	39.79	1.77	54.57
6	July 26	July 29	1	5.24	4.01	1.67	10.92	36.72	1.47	63.88
7	July 27	August 1, 4	1	4.69	7.28	1.48	13.45	54.13	3.94	27.71
8	July 28	July 31	1	4.58	6.70	1.83	13.11	51.11	3.42	59.69
9	August 6	August 7	16	3.60	9.31	2.03	14.94	62.32	5.80	64.35
10	August 21	August 14, 21	15	2.58	12.30	2.83	17.71	69.45	8.54	64.78
11	September 2	August 14, 21	8	2.09	12.09	3.10	17.28	69.97	8.46	64.02
12	September 8	August 28	16	1.85	11.59	2.82	16.26	71.28	8.26	64.74
13		August 31	2	1.85	12.10	3.06	17.01	71.13	8.61	
14	September 18	September 4	9	1.84	12.61	3.33	17.78	70.92	8.94	60.24
15	September 24	September 9	3	1.51	13.99	3.36	18.86	74.18	10.38	59.41
16	October 2	September 14	8	1.42	14.01	3.19	18.62	75.24	10.54	61.53
17	October 22		6	1.25	15.03	4.28	20.56	73.06	10.98	59.24
18	November 5		9	1.34	12.95	3.72	18.01	71.35	9.24	64.87

TABLE No. 68.—NEEAZANA. BLYMYER & CO., CINCINNATI, OHIO.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
1	July 19	July 12	1	5.18	1.12	1.60	7.90	14.18	.16	57.98
2	July 21	July 16	1	5.55	2.04	2.00	9.59	21.27	.43	56.89
3	July 23	July 20	2	5.23	2.54	1.33	9.10	27.91	.71	56.07
4	July 23	July 24	2	4.80	2.54	1.57	8.91	28.51	.72	53.25
5	July 26	July 28	1	4.11	4.01	1.79	9.91	40.46	1.62	56.49
6	July 27	July 31	1	4.63	4.91	2.36	11.90	41.26	2.03	59.35
7	July 28	August 4	1	4.86	6.53	2.08	13.47	48.48	3.17	59.82
8	July 30	August 8, 14	1	4.50	6.88	2.73	14.11	48.76	3.35	65.24
9	August 10	August 7, 14	21	3.57	9.80	2.48	15.85	61.83	6.06	64.81
10	August 22	August 21	6	2.66	12.05	3.03	17.74	67.93	8.19	64.74
11	August 27	August 28	4	2.77	11.76	3.00	17.53	67.08	7.89	64.12
12	August 30	September 4	8	2.54	11.84	3.18	17.56	67.43	7.98	62.81
13	September 7	September 11	7	2.26	13.06	1.95	17.27	75.62	9.88	61.49
14	September 10	September 18	8	2.28	13.07	2.48	17.83	73.30	9.58	62.80
15	September 20	September 25	4	2.02	13.04	2.91	17.97	72.57	9.46	56.35
16	September 30	October 1	12	1.77	13.76	3.51	19.04	72.27	9.94	58.43
17	October 20		6	1.53	14.65	4.70	20.88	70.17	10.28	59.40
18	November 4		9	1.84	13.13	3.10	18.07	72.66	9.54	61.65

TABLE No. 69.—NEW VARIETY. E. LINK, GREENEVILLE, TENN.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
1	July 24	July 20	1	3.43	3.95	1.93	9.31	42.43	1.68	57.78
2	July 24	July 24	1	3.60	4.08	1.96	9.64	42.32	1.73	50.12
3	July 26	July 28	1	3.55	4.70	1.89	10.14	46.35	2.18	57.85
4	July 28	July 31	2	3.46	5.56	2.77	11.79	47.16	2.62	62.04
5	July 30	August 3	2	3.09	5.49	2.30	10.88	50.46	2.77	62.66
6	July 31	August 4	1	2.80	7.99	4.13	14.92	53.54	4.44	69.04
7	August 5	August 5	1	2.49	9.40	3.68	15.57	60.37	5.67	65.41
8	August 5	August 7	1	2.72	8.33	3.14	14.19	58.70	4.89	67.22
9	August 15	August 14	3	2.19	10.16	2.91	15.26	66.58	6.76	64.01
10	August 23	August 21	2	1.44	11.75	2.24	15.43	76.15	8.95	68.67
11	August 25	August 28	2	1.56	11.21	2.93	15.70	71.40	8.00	71.89
12	August 30	August 31	2	1.49	11.38	2.99	15.86	71.75	8.17	66.83
13	September 2	September 4	2	1.35	12.43	2.77	16.55	75.11	9.34	65.04
14	September 7	September 10	8	1.07	12.34	2.92	16.33	75.57	9.33	66.69
15	September 15	September 17	2	.94	13.57	3.64	18.15	74.77	10.15	60.91
16	September 28	September 25	6	1.19	12.75	3.15	17.09	74.60	9.51	64.40
17	October 21		4	.61	15.63	5.32	21.56	72.50	11.33	61.38
18	November 4		3	1.02	14.53	4.18	19.73	73.64	10.70	61.21

AVERAGES OF EACH STAGE OF EACH VARIETY—Continued.

TABLE NO. 70.—CHINESE. D. SMITH, ARLINGTON, VA.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.
1	July 20	July 24	1	4.51	2.15	1.67	8.33	25.81	.55	54.99
2	July 23	July 28	2	5.21	1.32	2.01	8.54	15.46	.20	50.40
3	July 23	July 31	1	5.04	1.59	1.70	8.33	19.09	.30	59.14
4	July 26	August 2	1	5.53	2.29	1.95	9.77	23.43	.54	59.78
5	July 27	August 3	1	4.64	4.62	2.45	11.71	39.45	1.82	57.69
6	July 30	August 4	1	4.70	4.58	2.24	11.52	39.76	1.82	63.95
7	July 31	August 5	1	4.52	5.41	2.51	12.44	43.49	2.35	68.18
8	August 2	August 7, 14	1	5.46	5.58	1.69	12.73	43.83	2.45	66.95
9	August 10	August 7, 14, 21	21	4.20	7.00	2.42	13.62	52.86	3.70	65.64
10	August 20	August 21	8	3.34	9.04	2.40	14.78	61.16	5.53	69.20
11	August 24	August 24	4	3.07	9.52	2.30	14.89	63.94	6.09	67.68
12	August 27	August 28	4	3.25	8.15	2.55	13.95	58.42	4.76	68.21
13	September 1	September 4	4	2.99	9.55	2.52	15.06	63.41	6.05	66.90
14	September 4	September 11	4	3.10	10.75	2.21	16.06	66.04	7.20	65.85
15	September 15	September 19	11	2.30	11.90	2.53	16.73	71.13	8.46	62.74
16	October 1	September 28	12	1.88	13.10	3.79	18.77	69.79	9.14	60.75
17	October 19		6	1.33	14.61	5.09	21.03	69.47	9.83	56.72
18	November 4		7	1.72	13.09	3.31	18.12	72.24	9.46	61.51

TABLE NO. 71.—WOLF TAIL. E. LINK, GREENEVILLE, TENN.

1	July 30	July 28	1	2.82	4.19	2.20	9.21	45.49	1.91	62.50
2	July 30	July 31	1	5.19	1.24	2.46	8.89	13.95	.17	63.29
3	August 2	August 1	1	3.96	4.60	2.89	11.45	40.17	1.85	65.04
4	August 2	August 2	1	2.63	4.90	1.49	9.02	54.32	2.66	68.78
5	August 3	August 4	2	2.39	6.25	2.20	10.84	57.66	3.60	67.32
6	August 6	August 7	1	2.78	5.99	2.61	11.38	52.64	3.15	65.66
7	August 6	August 14, 21	1	2.28	6.79	2.68	11.75	57.79	3.92	68.24
8	August 16	August 14, 21	3	2.31	10.28	2.99	15.58	65.98	6.78	61.53
9	August 19	August 28	2	1.87	10.08	2.87	14.82	68.02	6.86	65.90
10	August 26	August 31	2	1.74	10.78	2.23	14.75	73.08	7.88	63.70
11	September 2	September 4	4	1.34	10.29	2.86	14.49	71.01	7.31	64.24
12	September 8	September 11	2	1.30	8.73	3.11	13.14	66.44	5.80	63.62
13	September 18	September 18	2	1.11	11.96	3.56	16.63	71.92	8.60	60.27
14	September 23	September 25	2	1.12	12.54	2.17	15.83	79.22	9.93	58.27
15	October 2	October 2	5	1.27	13.46	2.89	17.62	76.39	10.28	61.92
16	October 20	October 20	4	.71	14.31	4.06	19.08	75.00	10.72	62.45

TABLE NO. 72.—GRAY TOP. H. C. SEALEY, COLUMBIA, TENN.

1	July 20	July 24	1	3.19	2.16	1.79	7.14	30.25	.65	51.54
2	July 23	July 28	1	3.53	3.75	1.80	9.08	41.30	1.55	51.08
3	July 26	July 31	1	3.37	4.80	1.59	9.76	49.18	2.36	61.42
4	July 27	August 2	1	3.30	4.08	2.95	10.33	39.50	1.61	57.70
5	July 30	August 4	2	2.67	6.81	3.49	12.97	52.51	3.58	60.54
6	July 31	August 5	1	3.30	5.81	2.58	11.69	49.70	2.89	68.68
7	August 2	August 6	1	2.89	8.72	2.92	14.53	60.01	5.23	67.02
8	August 5	August 7, 12	5	2.93	6.40	2.79	12.12	52.80	3.38	69.02
9	August 13	August 7, 14	21	2.39	8.61	2.63	13.63	63.17	5.44	67.39
10	August 24	August 17, 23	4	2.14	7.70	2.58	12.42	62.00	4.77	68.96
11	August 27	August 21, 28	4	2.16	7.71	2.58	12.45	61.93	4.77	70.04
12	September 1	August 29	4	2.17	7.22	2.44	11.83	61.03	4.41	62.37
13	September 4	September 4	4	2.14	8.87	2.61	13.62	65.12	5.78	61.70
14	September 9	September 10	4	1.70	9.61	2.46	13.77	69.79	6.71	68.44
15	September 17	September 17	4	1.81	11.64	3.18	16.63	70.00	8.15	65.68
16	September 28	September 28	16	1.33	13.09	3.66	18.08	72.40	9.48	62.02
17	October 20		7	1.30	15.00	4.29	20.59	72.85	10.93	58.73
18	November 6		6	1.43	12.40	3.04	16.87	73.50	9.11	65.56

AVERAGES OF EACH STAGE OF EACH VARIETY—Continued.

TABLE No. 73.—LIBERIAN. BLYMYER & Co., CINCINNATI, OHIO.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.
1	July 29	July 25	3	4.22	3.26	2.33	9.81	33.23	1.08	63.09
2	July 29	July 28	2	4.83	2.56	1.56	8.95	28.60	.73	65.13
3	July 29	July 31	2	4.97	2.93	2.05	9.95	29.45	.86	66.12
4	July 29	August 3	2	4.84	2.67	2.06	9.57	27.90	.74	71.29
5	August 1	August 6	2	4.21	5.38	2.35	11.94	45.06	2.42	65.80
6	August 3	August 9, 12	1	4.39	5.85	2.43	12.67	46.17	2.70	66.63
7	August 6	August 7, 16	1	4.19	5.94	2.07	12.20	48.69	2.87	67.67
8	August 11	August 14, 21	9	4.26	7.47	2.29	14.02	53.27	3.98	65.74
9	August 16	August 21, 28	4	3.55	8.33	2.52	14.40	57.85	4.82	67.94
10	August 23	August 28	6	3.35	9.14	2.69	15.18	60.21	5.50	63.88
11	August 29	September 4	8	2.96	9.51	2.72	15.19	62.61	5.95	67.19
12	September 3	September 8	4	2.74	10.71	2.45	15.90	67.36	7.21	66.18
13	September 12	September 13	5	2.34	12.76	2.88	17.98	70.97	9.06	62.81
14	September 20	September 18	4	1.90	13.18	3.07	18.15	71.62	9.44	62.37
15	September 25	September 24	5	2.33	12.94	3.27	18.54	69.80	9.03	61.81
16	October 2	October 2	8	1.61	13.85	3.64	19.10	72.51	10.04	61.08
17	October 21		7	1.47	15.85	4.48	21.80	69.04	10.95	61.26
18	November 7		7	1.74	13.12	3.95	18.81	55.29	7.25	64.87

TABLE No. 74.—LIBERIAN. W. H. LYTLE, YELLOW SPRINGS, OHIO.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
1	July 21	July 25	1	4.42	2.33	1.48	8.23	28.31	.66	48.28
2	July 27	July 28	1	5.13	1.55	1.72	8.40	18.45	.29	63.57
3	July 27	July 31	1	5.11	2.01	1.96	9.08	22.14	.45	64.75
4	July 27	August 3	1	5.06	2.23	2.73	10.02	22.26	.50	60.16
5	August 1	August 4	2	4.78	4.76	1.89	11.43	41.64	1.98	66.86
6	August 4	August 5	2	4.30	6.74	1.92	12.96	52.01	3.51	63.56
7	August 7	August 7, 14	1	4.27	7.09	2.38	13.74	51.60	3.62	63.74
8	August 13	August 14, 21	13	4.20	7.68	2.31	14.19	54.12	4.16	65.27
9	August 20	August 21	4	3.59	8.67	2.69	14.95	57.99	5.03	66.36
10	August 24	August 28	4	3.68	8.38	2.42	14.48	56.49	4.73	68.19
11	August 26	September 4	4	3.32	9.18	2.79	15.29	60.04	5.51	66.72
12	September 1	September 8	4	3.09	9.61	2.61	15.31	62.77	6.03	65.88
13	September 3	September 12	4	2.93	10.56	2.06	15.55	67.91	7.17	66.06
14	September 8	September 16	8	2.53	11.80	2.23	16.56	71.26	8.41	66.72
15	September 18	September 21	8	2.24	12.50	3.03	17.77	70.34	8.79	59.61
16	September 30	September 26	12	2.11	12.97	3.64	18.72	69.28	8.99	62.12
17	October 25		8	1.47	14.39	4.59	20.45	70.37	10.12	61.78
18	November 3		8	2.03	13.00	3.95	18.98	68.50	8.91	62.42

TABLE No. 75.—OOMSEEANA. W. I. MAYES & Co., SWEET WATER, TENN.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
1	July 27	July 27	1	4.75	1.35	2.67	8.77	15.39	.21	62.65
2	July 28	July 31	1	4.43	3.14	2.01	9.58	32.78	1.03	56.08
3	July 31	August 2	2	4.94	4.03	2.40	11.37	35.44	1.43	67.12
4	August 2	August 3	3	4.90	5.03	2.05	11.98	41.99	2.11	67.87
5	August 3	August 4	1	5.16	5.83	2.23	13.22	44.10	2.57	68.21
6	August 5	August 7	2	4.62	6.16	2.28	13.06	47.17	2.91	66.35
7	August 10	August 14, 21	6	4.61	7.35	2.14	14.10	52.13	3.83	65.40
8	August 14	August 14, 21	8	4.20	8.47	2.35	15.02	56.39	4.78	66.31
9	August 24	August 28	10	3.48	9.28	3.20	15.96	58.15	5.40	65.45
10	September 1	August 31	4	3.07	10.39	2.70	16.16	64.29	6.68	64.33
11	September 4	September 4	4	3.05	10.40	2.70	16.15	64.40	6.70	63.47
12	September 9	September 9	4	2.27	11.78	2.13	16.18	72.81	8.58	64.82
13	September 16	September 15	4	2.02	13.65	2.95	18.62	73.31	10.01	62.23
14	September 22	September 20	5	1.89	13.45	3.16	18.50	72.07	9.69	62.87
15	September 24	September 25	3	1.54	13.42	4.06	19.02	70.01	9.40	61.18
16	October 3	October 2	7	1.57	14.11	3.79	19.47	72.86	10.28	59.95
17	October 20		6	1.41	14.83	4.26	20.50	72.34	10.73	59.96
18	November 5		7	1.49	14.07	3.42	18.98	74.13	10.43	62.11

AVERAGES OF EACH STAGE OF EACH VARIETY—Continued.

TABLE No. 76.—SUMAC. W. POPE, ———, ALA.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.
1	July 27	July 31	1	4.80	2.99	2.58	10.37	28.83	.86	41.64
2	July 27	August 2	1	5.07	3.11	2.39	10.57	29.42	.91	58.51
3	July 31	August 4	1	5.27	4.50	2.22	11.99	37.53	1.69	66.88
4	August 1	August 5	2	5.15	4.10	1.69	10.94	37.48	1.54	68.47
5	August 3	August 6	1	5.35	6.36	1.79	13.50	47.11	3.00	67.45
6	August 7	August 7	2	4.87	6.90	2.12	13.89	49.68	3.43	67.14
7	August 11	August 10	5	4.87	7.35	1.78	14.00	52.50	3.86	66.01
8	August 15	August 14	8	4.43	8.34	2.49	15.26	54.65	4.56	66.29
9	August 22	August 21	4	3.71	9.82	2.38	15.91	61.72	6.06	66.15
10	August 27	August 28	4	3.63	9.72	2.64	15.99	60.79	5.91	61.56
11	September 1	August 31	4	3.29	9.81	2.67	15.77	62.21	6.10	63.72
12	September 4	September 4	4	3.18	10.01	2.74	15.93	62.84	6.29	64.72
13	September 9	September 9	4	3.30	8.82	2.02	14.14	62.38	5.50	65.90
14	September 19	September 16	7	2.97	12.12	3.01	18.10	66.96	8.12	61.38
15	September 24	September 24	4	1.79	13.30	3.98	19.07	69.69	9.27	62.02
16	October 4	October 4	8	1.81	13.32	3.89	19.02	70.03	9.33	60.02
17	October 20		6	1.53	15.16	4.47	21.16	71.60	10.85	60.27
18	November 4		6	1.60	13.18	4.61	19.39	67.46	8.89	60.52

TABLE No. 77.—MASTODON. D. W. AIKEN, COKESBURY, S. C.

1	July 26	July 16, 31	1	2.53	4.19	3.02	9.74	43.02	1.80	59.56
2	July 26	August 7, 14	1	3.49	4.60	2.06	10.15	45.32	2.08	54.43
3	July 26	August 7, 14	1	4.63	2.72	1.64	8.99	31.03	.84	61.81
4	August 11	August 21	3	3.75	5.00	2.08	10.83	46.17	2.31	67.15
5	August 15	August 23	4	3.76	7.84	1.67	13.27	50.08	4.63	66.49
6	August 21	August 24	4	3.67	7.04	1.87	12.58	55.96	3.94	69.06
7	August 26	August 26	4	2.99	9.48	2.30	14.77	64.18	6.08	66.88
8	August 28	August 28	2	2.17	9.58	2.62	14.37	66.67	6.39	57.49
9	September 2	August 31	2	2.34	9.61	2.43	14.38	66.83	6.42	66.46
10	September 7	September 4	8	2.84	9.68	2.70	15.22	63.60	6.16	67.31
11	September 7	September 10	8	1.09	9.80	2.73	13.62	71.95	7.05	65.68
12	September 14	September 15	2	1.40	7.98	3.49	12.87	62.00	4.95	67.56
13	September 22	September 20	2	2.24	11.93	2.31	16.48	72.39	8.64	64.04
14	September 23	September 26	2	2.30	9.28	2.52	14.10	65.82	6.11	67.51
15	September 25	October 2	2	2.02	10.04	2.48	14.54	69.05	6.93	66.31
16	October 4	October 9	4	1.37	13.58	3.04	17.99	75.49	10.25	61.16
17	October 21		3	1.32	16.05	4.67	22.04	72.82	11.69	57.60
18	November 9		2	2.79	12.68	3.28	18.75	67.63	8.58	64.95

TABLE No. 78.—IMPHEE. D. W. AIKEN, COKESBURY, S. C.

1	July 30	July 31	1	6.28	4.08	1.81	12.17	33.53	1.37	64.21
2	July 31	August 1	1	6.33	4.43	2.60	13.36	33.16	1.47	64.30
3	August 2	August 2	1	5.56	4.79	2.71	13.06	36.68	1.76	68.61
4	August 2	August 3	1	5.44	5.37	3.64	14.45	37.16	2.00	68.13
5	August 4	August 5	2	5.69	5.52	2.34	13.55	40.74	2.25	66.13
6	August 16	August 7	3	4.02	8.03	3.09	15.14	53.04	4.26	64.09
7	August 19	August 10	2	4.58	8.09	3.25	15.92	50.82	4.11	65.21
8	August 19	August 14, 21	2	4.57	8.81	3.08	16.46	53.52	4.72	60.03
9	August 24	August 21, 28	4	4.16	9.62	2.68	16.46	58.44	5.62	63.72
10	August 30	August 28	2	4.14	9.49	2.53	16.16	58.73	5.57	64.14
11	September 2	September 4	2	3.42	9.88	2.97	16.27	60.73	6.00	64.27
12	September 8	September 11	2	3.37	11.15	1.77	16.29	68.45	7.63	65.64
13	September 16	September 18	2	2.49	11.87	3.84	18.20	65.22	7.74	65.16
14	September 23	September 25	2	2.44	12.19	3.17	17.80	68.48	8.35	60.45
15	September 25	October 1	2	2.13	12.89	3.53	18.55	69.49	8.96	54.38
16	October 7	October 7	2	2.14	13.02	2.82	17.98	72.41	9.43	63.28
17	October 21		4	1.58	15.31	4.45	21.34	71.74	10.98	61.08
18	November 5		3	1.57	14.29	3.57	19.43	73.54	10.51	60.65

AVERAGES OF EACH STAGE OF EACH VARIETY—Continued.

TABLE NO. 79.—NEW VARIETY. J. W. H. SALLE, STRAFFORD, MO.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.
1	July 26	July 26	1	5.44	2.30	2.30	10.04	22.91	.53	59.74
2	July 26	July 29	1	5.26	1.86	1.50	8.62	21.58	.40	58.70
3	July 26	July 31	1	5.32	1.86	1.58	8.76	21.24	.40	60.02
4	July 30	August 3	1	5.03	2.93	1.77	9.73	30.11	.88	65.55
5	July 31	August 7, 14	2	4.95	3.32	2.30	10.57	31.41	1.04	66.92
6	August 3	August 7, 14	1	4.77	5.89	1.92	12.58	46.82	2.76	69.36
7	August 6	August 21	1	4.96	4.51	2.01	11.48	39.29	1.77	77.81
8	August 10	August 24	9	4.40	6.86	2.15	13.41	51.16	3.51	68.04
9	August 20	August 28	6	3.40	9.47	2.23	15.10	62.62	5.93	65.19
10	August 24	September 4	8	4.01	7.77	1.87	13.65	56.92	4.42	61.74
11	August 28	September 10	4	3.80	9.07	2.58	15.45	58.71	5.33	61.00
12	September 2	September 16	4	3.71	6.47	2.19	12.37	52.30	3.38	66.24
13	September 21	September 22	4	3.24	9.74	2.77	15.75	61.84	6.02	62.76
14	September 23	September 28	4	2.98	10.98	2.65	16.61	66.10	7.26	62.72
15	September 25	October 4	4	2.57	12.39	3.01	17.97	69.00	8.55	59.88
16	October 5	October 11	10	2.56	12.55	2.90	18.01	69.68	8.74	60.17
17	October 24		5	2.02	13.99	3.73	19.74	70.88	9.92	58.59
18	November 1		6	2.15	12.12	3.14	17.41	69.60	8.44	55.75

TABLE NO. 80.—SUMAC. J. H. WIGHTON, MOUNT OLIVE, ALA.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
1	August 2	August 2	1	6.67	3.85	2.11	12.63	30.48	1.17	65.81
2	August 2	August 4	1	6.07	3.70	2.10	11.87	31.17	1.15	65.27
3	August 2	August 6	1	6.48	3.64	2.14	12.26	29.69	1.08	68.20
4	August 4	August 7	2	5.45	4.98	2.52	12.95	38.46	1.92	64.50
5		August 8	2	5.07	6.70	2.69	14.46	46.33	3.10	
6	August 19	August 10	2	5.11	7.13	2.56	14.80	48.18	3.44	64.09
7	August 19	August 12	2	4.76	7.63	3.07	15.46	49.35	3.77	65.68
8	August 19	August 14	2	4.27	8.89	2.55	15.71	56.27	5.00	64.14
9	August 24	August 21	4	3.39	9.67	2.33	15.39	62.83	6.08	64.45
10	August 30	August 28	2	4.07	9.21	2.33	15.61	59.00	5.43	64.72
11	September 2	August 31	2	4.09	8.50	2.40	14.99	56.70	4.82	67.13
12	September 7	September 4	2	3.39	10.07	2.53	15.99	62.98	6.34	65.40
13	September 15	September 12	2	2.98	10.31	4.43	17.72	58.18	6.00	64.47
14	September 24	September 22	4	2.55	12.43	3.23	18.21	68.26	8.48	59.56
15	October 7	October 5	1	1.71	11.26	5.94	18.91	59.55	6.71	59.90
16	October 20	October 20	4	2.08	14.93	3.68	20.69	72.11	10.77	62.38
17	November 9		2	1.52	13.86	3.11	18.49	74.95	10.39	59.30

TABLE NO. 81.—HONDURAS. ARSENAL, WASHINGTON, D. C.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
1	July 23	July 19	1	3.55	1.31	2.32	7.18	18.24	.24	42.32
2	July 26	July 24	1	3.28	1.99	1.78	7.05	28.23	.56	49.01
3	July 26	July 28	1	3.16	4.27	2.10	9.53	44.81	1.91	48.94
4	July 26	July 31, August 7	1	3.90	3.82	2.79	10.51	36.35	1.39	40.75
5	July 30	August 14	1	3.08	5.60	2.34	11.02	50.82	2.85	64.50
6	August 2	August 7, 14, 21	1	2.83	5.77	2.93	11.53	50.04	2.89	56.00
7	August 6	August 21	1	5.13	3.08	2.02	10.23	30.11	.93	68.55
8	August 10	August 28	2	2.15	6.27	2.48	10.90	57.52	3.61	61.34
9	August 17	September 4	12	2.49	6.85	2.55	11.89	57.61	3.95	57.55
10	August 25	September 10	4	1.87	7.17	2.94	11.98	59.85	4.29	49.95
11	August 28	September 15	3	3.20	5.69	2.44	11.33	50.22	2.86	64.21
12	September 4	September 20	8	1.70	5.72	3.12	10.54	54.27	3.10	47.08
13	September 14	September 25	4	3.81	5.79	1.86	11.46	50.52	2.93	62.43
14	September 21	September 30	4	1.82	10.30	3.08	15.20	67.76	6.98	48.78
15	September 24	October 6	8	2.73	9.24	2.86	14.83	62.31	5.76	60.79
16	October 3	October 14	9	2.31	9.63	3.01	14.95	64.41	6.20	58.51
17	October 25		6	2.16	12.11	3.39	17.66	68.57	8.30	60.29
18	October 29		6	2.17	9.30	3.39	14.86	62.58	5.82	55.75

AVERAGES OF EACH STAGE OF EACH VARIETY—Continued.

TABLE No. 82.—HONEY CANE. J. H. CLARK, PLEASANT HILL, LA.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
				Pr. ct.	*Pr. ct.*	*Pr. ct.*	*Pr. ct.*		*Pr. ct.*	*Pr. ct.*
1	July 30	August 2	1	4.72	2.74	2.00	9.46	28.96	.79	66.15
2	July 30	August 7	1	4.61	2.38	1.67	8.66	27.48	.65	66.69
3	August 5	August 14	2	4.57	3.63	2.25	10.45	34.74	1.26	70.31
4	August 10	August 16	5	4.64	2.96	1.91	9.51	31.12	.92	66.41
5	August 16	August 18	11	4.46	4.52	1.83	10.81	41.81	1.89	69.47
6	August 21	August 21	4	4.36	5.89	1.70	11.95	49.29	2.90	70.12
7	August 25	August 24	4	3.99	6.60	1.60	12.19	54.14	3.57	69.27
8	August 27	August 28	4	3.83	7.14	2.41	13.38	53.36	3.81	66.35
9	September 2	August 31	4	3.73	7.77	1.58	13.08	59.40	4.62	67.53
10	September 12	September 4	8	3.34	8.70	1.98	14.02	62.05	5.40	68.84
11	September 18	September 9	8	3.08	9.29	1.94	14.31	64.92	6.03	65.30
12	September 23	September 15	4	4.82	11.29	1.86	15.97	70.70	7.98	66.28
13	September 25	September 21	4	3.30	8.85	2.13	14.28	61.97	5.48	66.16
14	September 28	September 28	4	2.94	9.29	2.14	14.37	64.65	6.01	64.02
15	October 7	October 6	5	2.10	11.78	2.87	16.75	70.33	8.28	64.71
16	October 18	October 16	4	1.63	12.81	3.56	18.00	71.17	9.12	64.25
17	October 28		5	1.97	12.91	3.58	18.46	69.93	9.03	64.57
18	November 11		4	2.61	9.65	2.75	15.01	64.29	6.20	69.67

TABLE No. 83.—SPRANGLE TOP. W. POPE, ——, ALA.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
1	August 9	August 7	6	4.78	3.18	1.63	9.59	33.16	1.05	69.98
2	August 15	August 11	9	4.75	2.83	2.00	9.58	29.54	.84	67.59
3	August 19	August 14	5	4.77	3.78	1.59	10.14	37.28	1.41	70.71
4	August 25	August 18	4	5.59	4.21	1.71	11.51	36.58	1.54	69.67
5	August 28	August 21	4	5.26	4.58	1.81	11.65	39.31	1.80	69.67
6	August 30	August 23	4	4.68	6.41	1.93	13.02	49.39	3.17	71.44
7	August 30	August 25	4	4.64	6.58	2.02	13.24	49.70	3.27	69.49
8	August 30	August 28	4	4.25	7.22	2.69	14.16	50.99	3.68	69.76
9	August 30	September 4	4	4.10	7.92	2.18	14.20	55.77	4.42	69.12
10	September 4	September 11	8	3.76	8.14	1.82	13.72	59.33	4.83	70.34
11	September 14	September 17	4	4.04	6.78	1.83	12.65	53.60	3.63	65.44
12	September 21	September 23	4	4.03	8.53	1.60	14.16	60.24	5.14	64.76
13	September 24	September 29	7	2.68	9.92	2.43	15.03	66.00	6.55	65.09
14	September 29	October 5	5	2.40	11.25	2.55	16.20	69.45	7.81	63.49
15	October 9	October 11	4	3.28	8.96	2.29	14.53	61.67	5.53	65.86
16	October 21	October 17	3	2.86	12.03	3.73	18.62	64.61	7.77	67.79
17	October 23		3	2.25	12.62	3.37	18.24	69.19	8.73	64.22
18	November 6		5	2.28	11.19	2.74	16.21	69.03	7.73	68.19

TABLE No. 84.—HONDURAS. E. LINK, GREENEVILLE, TENN.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
1	August 18	August 14	4	4.36	3.05	1.65	9.06	33.66	1.03	67.52
2	August 23	August 18	4	4.43	5.14	1.47	11.04	46.56	2.39	68.05
3	August 25	August 21	4	4.78	3.60	1.50	9.88	36.44	1.31	65.25
4	August 28	August 24	4	4.68	4.70	1.68	11.06	42.50	2.00	67.33
5	September 2	August 28	4	5.00	4.57	1.52	11.09	41.21	1.88	69.89
6	September 6	August 31	4	3.57	8.22	1.95	13.74	59.83	4.92	68.41
7		September 4	......	4.13	7.09	1.96	13.18	53.79	3.81	......
8	September 14	September 11	4	4.28	6.78	2.12	13.18	51.44	3.49	69.89
9	September 21	September 18	4	3.65	8.77	2.23	14.65	59.86	5.25	64.60
10	September 23	September 24	4	3.47	9.08	1.91	14.46	62.79	5.70	65.54
11	September 26	October 1	5	3.02	9.74	2.54	15.30	63.66	6.20	66.94
12	October 10	October 9	4	1.80	12.83	2.95	17.58	72.98	10.06	65.06
13	October 19	October 19	4	2.35	11.58	3.52	17.45	66.36	7.68	65.60
14	October 29	October 29	3	3.38	11.97	2.84	18.19	65.81	7.88	64.22
15	November 4	November 4	2	4.30	10.98	3.43	18.71	58.69	6.44	61.45
16	November 13	November 13	1	3.65	10.31	2.00	15.96	64.60	6.66	67.87

AVERAGES OF EACH STAGE OF EACH VARIETY—Continued.

TABLE NO. 85.—HONEY TOP OR TEXAS CANE. ——— ———, BRUSSELS, MO.

Stage.	Average date of estimation.	Observed date of reaching stage.	No. of determinations.	Glucose.	Sucrose.	Solids not sugar.	Total solids.	Exponent.	Available sucrose.	Average juice.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.		Pr. ct.	Pr. ct.
1	August 10	August 7	6	4.86	2.03	1.78	8.67	23.41	.48	69.07
2	August 16	August 14	11	4.74	2.67	1.76	9.17	29.12	.78	70.21
3	August 21	August 17	4	4.74	3.61	1.34	9.69	37.25	1.34	70.55
4	August 25	August 19	4	4.81	4.29	1.29	10.39	41.29	1.77	71.11
5	August 28	August 21	4	4.69	4.48	1.53	10.70	41.87	1.88	71.11
6	August 30	August 23	4	4.80	6.17	2.00	12.97	47.57	2.93	68.95
7	August 30	August 25	4	4.15	6.64	1.97	12.76	52.04	3.46	69.69
8	August 30	August 28	4	4.28	6.48	2.07	12.83	50.51	3.27	70.58
9	September 1	September 4	8	4.19	7.16	1.75	13.10	54.66	3.91	69.51
10	September 6	September 9	4	4.09	6.73	1.88	12.70	52.99	3.57	70.61
11	September 16	September 14	8	4.04	6.78	2.39	13.21	51.32	3.45	68.37
12	September 21	September 20	4	3.96	7.64	1.90	13.50	56.59	4.32	68.28
13	September 24	September 25	8	3.16	9.71	2.50	15.37	63.18	6.13	64.95
14	September 28	September 30	4	2.92	10.25	2.49	15.66	65.45	6.71	65.56
15	October 7	October 7	5	2.91	11.22	2.67	16.80	66.79	7.49	66.19
16	October 18	October 15	3	1.96	12.77	4.07	18.80	67.93	8.67	63.80
17	October 23	....	4	2.26	13.18	3.77	19.21	68.61	9.04	65.46
18	November 4	....	6	3.38	9.19	2.55	15.12	60.78	5.59	69.88

TABLE NO. 86.—HONDURAS. L. BRANDE, MAYERSVILLE, TEX.

1	August 12	August 7	5	4.61	2.66	1.62	8.89	29.92	.80	68.27
2	August 16	August 10	5	4.84	3.09	1.72	9.65	32.02	.99	70.20
3	August 20	August 13, 17	5	4.55	3.92	1.39	9.86	39.76	1.56	66.39
4	August 25	August 14, 21	4	4.87	4.15	1.61	10.63	39.04	1.62	70.84
5	August 28	August 22	4	5.03	5.45	1.77	12.25	44.49	2.42	68.23
6	September 2	August 28	4	4.79	5.28	1.55	11.62	45.44	2.40	64.92
7	September 6	September 4	4	4.25	7.24	1.96	13.45	53.83	3.90	68.19
8	September 10	September 10	8	4.09	7.26	2.46	13.81	52.57	3.82	67.33
9	September 14	September 16	8	3.78	8.34	1.72	13.84	60.26	5.03	66.61
10	September 23	September 22	4	3.25	8.90	1.59	13.74	64.77	5.76	65.18
11	September 25	September 27	4	3.04	9.95	2.51	15.50	64.19	6.39	65.51
12	September 28	October 3	4	3.13	8.47	1.92	13.52	62.65	5.31	66.24
13	October 12	October 9	5	2.79	10.91	2.69	16.39	66.57	7.26	67.43
14	October 11	October 16	3	1.66	11.29	3.50	16.45	68.63	7.75	70.30
15	October 24	October 24	4	2.39	12.05	2.93	17.37	69.37	8.36	62.88
16	November 7	November 7	5	2.84	11.07	2.89	16.80	65.89	7.29	69.63

TABLE NO. 87.—"SUGAR CANE." C. E. MILLER, EFFINGHAM, ILL.

1	July 13	July 3	1	3.94	1.71	1.09	6.74	25.37	.43	58.30
2	July 16	July 8	1	4.36	2.30	1.05	7.71	29.70	.68	44.37
3	July 17	July 12	1	3.92	2.35	1.87	8.14	28.87	.68	51.61
4	July 17	July 16	1	4.41	3.18	1.58	9.17	34.68	1.10	47.60
5	July 20	July 19	1	3.73	5.97	1.96	11.66	51.20	3.06	54.99
6	July 21	July 22	1	3.23	5.24	2.46	10.93	47.94	2.51	56.25
7	July 23	July 25	1	3.38	6.96	1.77	12.11	57.47	4.00	57.29
8	July 23	July 28	1	4.12	5.94	2.35	12.41	47.86	2.84	63.29
9	July 27	July 31	3	3.26	8.06	2.45	13.77	58.51	4.72	59.02
10	August 3	August 7	9	2.67	8.20	2.69	13.56	60.47	4.96	62.14
11	August 8	August 12, 16	2	2.60	9.31	1.99	13.90	66.98	6.24	65.33
12	August 13	August 14, 21	4	2.13	8.37	2.62	13.12	63.80	5.34	63.87
13	August 18	August 20	7	2.39	7.14	3.42	12.95	55.14	3.94	65.94
14	August 21	August 24	4	3.06	3.53	2.33	8.92	39.57	1.40	67.05
15	August 25	August 28	4	3.22	7.19	2.22	12.63	56.93	4.09	66.52
16	September 9	September 4	24	3.00	8.06	2.29	13.35	60.37	4.87	64.63
17	October 7	....	17	2.70	10.14	3.22	16.06	63.14	6.40	61.44
18	November 8	....	6	2.39	10.47	3.13	15.99	65.48	6.86	63.05

GENERAL AVERAGES FOR EACH STAGE.

The following table (No. 88), deduced from the results of 2,739 analyses of sorghum canes, presents, in a condensed form, a very correct idea as to the actual development of the cane itself and of the changes in the juice.

Among the points of most practical interest may be mentioned the following:

1st. The changes in height, weight, diameter, and total and stripped weight are not sufficiently important to require comment.

2d. The percentage of juice extracted from the stripped stalks gradually increases up to the eleventh stage, then slowly diminishes until the close of the season.

3d. The specific gravity of the juice, the percentage of sucrose, the percentage of solids not sugar, and the exponent regularly increase (with but one or two exceptions) until the close of the season; and the percentage of glucose in the juice as steadily decreases from the first.

It will here be noticed that the sucrose increases in the juice much more rapidly than do the solids not sugar; and this fact taken together with the steady decrease of glucose is the explanation of the equally steady increase of the exponent, which represents the comparative purity of the juices.

4th. It is stated in the discussion of the table of specific gravities (Table 89) that the proper stage in the development of sorghum at which to begin the manufacture of sugar is when the juice has the specific gravity 1.066, corresponding with the exponent 70.

Confirmation of this statement is here furnished by this table, and we further see that this specific gravity (1,066) and exponent (70.15) are attained when the cane reaches what has been named the "13th stage."

By reference to the table describing these stages it appears that the seed of the plant should be quite fully developed andhard.

By these three indications every cane-grower can judge for himself as to the proper time to work up his sorghum crop, in order that he may obtain satisfactory results.

At the same time an analysis of the juice is always valuable and should be made when practicable.

TABLE NO. 88.—*General average for the stages, as determined from the results of the same stage for all varieties of sorghum.*

Stages.	Average length.	Diameter.	Unstripped weight.	Stripped weight.	Per cent. of juice.	Specific gravity.	Per cent. glucose.	Per cent. sucrose.	Per cent. solids.	Exponent.	Per cent. available sucrose.	Number of juices analyzed.
1	7.5	0.9	1.93	1.34	59.06	1.031	4.29	1.76	1.75	22.56	0.40	58
2	8.5	.9	1.93	1.46	59.60	1.036	4.45	2.96	1.86	31.93	.95	69
3	8.6	.9	1.78	1.39	59.67	1.037	4.50	3.51	1.78	35.85	1.26	57
4	9.1	.8	1.83	1.44	61.61	1.041	4.34	4.34	1.91	40.98	1.78	70
5	9.3	.9	1.96	1.55	63.05	1.045	4.15	5.13	1.92	45.80	2.35	75
6	9.7	.9	2.02	1.60	62.79	1.050	3.99	6.50	2.45	50.23	3.26	62
7	9.7	.9	2.11	1.55	63.85	1.052	3.86	7.38	2.19	54.95	4.06	70
8	9.3	1.0	2.10	1.63	65.68	1.055	3.83	7.69	2.37	55.36	4.26	111
9	8.8	.9	1.87	1.40	64.88	1.058	3.19	8.95	2.42	61.47	5.50	266
10	8.9	.9	1.81	1.38	64.83	1.061	2.60	9.98	2.50	66.18	6.60	217
11	9.1	.9	1.94	1.48	65.02	1.063	2.35	10.66	2.72	67.77	7.22	166
12	9.0	.9	1.81	1.37	63.39	1.065	2.07	11.18	2.83	69.53	7.77	170
13	9.1	.9	1.86	1.34	62.99	1.066	2.03	11.40	2.82	70.15	8.00	183
14	8.9	.9	1.82	1.32	61.72	1.067	1.88	11.76	2.96	70.84	8.33	191

TABLE No. 88.—*General average for the stages as determined from the results of the same stage for all varieties of sorghum*—Continued.

Stages.	Average length.	Diameter.	Unstripped weight.	Stripped weight.	Per cent. of juice.	Specific gravity.	Per cent. glucose.	Per cent. sucrose.	Per cent. solids.	Exponent.	Per cent. available sucrose.	Number of juices analyzed.
15	8.9	.9	1.81	1.32	60.45	1.067	1.81	11.69	3.15	70.21	8.21	217
16	8.7	.9	1.73	1.22	61.20	1.070	1.64	12.40	3.32	71.43	8.86	339
17	7.7	.9	1.69	1.25	60.17	1.078	1.56	13.72	4.07	70.90	9.73	197
18	8.5	.9	1.44	1.15	62.09	1.069	1.85	11.92	3.42	69.34	8.27	191
19*	8.5	1.0	1.81	1.53	56.04	1.080	3.09	12.08	3.62	64.70	7.82	30

*This stage (No. 19) was after the cane had ceased growing, late in the season; it was determined from canes Nos. 23 and 24 only.

EXPLANATION OF GRAPHICAL PLATES.

It has been found that graphical representations of the results of analyses tend to make more clear the changes which occur in the growing plant. Accordingly, the following plates have been carefully prepared; they are based on the data given in tables 51 to 87, which have just been explained.

It will be noticed that each square represents one day when viewed in a horizontal direction, while it equals one-fifth of 1 per cent. when examined vertically.

Three varieties of canes are exhibited and compared on each chart, and they are distinguished by lines of different colors; the average content of sucrose, glucose, and solids not sugar in the juices, is given for each cane, and distinguished by the different character of the lines.

Each stage in the development of the plant is shown by a straight line, and each angle marks the boundary between two stages; by reference to the date just above each angle, it will be seen at what time each particular stage began and ended for each plant.

It will here be noticed that the earlier stages extend over a very short period, while those stages in which the plant contains a considerable amount of sugar are much longer. This remark applies with especial force to the best varieties of cane, which appear among the first plates.

After the plates representing the history of the individual canes, comes a single plate, based on table No. 88, which shows the average for all varieties in each stage. From it may be gained a very truthful idea of the composition and changes of sorghum juices during growth.

EXPLANATION OF SPECIFIC GRAVITY TABLE.

The following table is one of considerable practical value to those engaged in sugar making from sorghum. By reference to it the sugar-boiler can determine quite accurately the composition of any juice of which he knows the specific gravity. These figures are averages drawn from all the analyses recorded, and although the different canes differ somewhat among themselves in the composition of the juice for the same specific gravity, still these differences are not so great as to be of much practical importance.

In examining these tables it should be remembered that the results are valuable in proportion to the number of analyses from which each

figure has been derived; therefore, while the figures derived from a small number of analyses are true for the particular canes examined, it is probable that a larger number of determinations would somewhat modify the results. If only those figures are examined which are based on ten or more analyses, it will be seen that the recorded results are very seldom exceptional.

Among other points shown by this table, the following are important:

1st. The amount of juice obtained seldom falls below 60 per cent. of the weight of the stripped stalks; this percentage does not vary greatly throughout the season.

2d. The amount of crystallizable sugar (sucrose) in the juice is at first little over 1 per cent., but it regularly increases with the increase of specific gravity. No one relationship is more evident than this close correspondence between the increase of specific gravity and percentage of sucrose in the juice; the average increase of sucrose for an increase of .001 in specific gravity (between 1.030 and 1.086) is 0.233 per cent. The following table shows the average increase of cane sugar corresponding with an increase of .001 *in specific gravity of the juice:*

Between 1.030—1.039=.164 per cent. sucrose.
Between 1.040—1.049=.167 per cent. sucrose.
Between 1.050—1.059=.229 per cent. sucrose.
Between 1.060—1.069=.250 per cent. sucrose.
Between 1.070—1.079=.142 per cent. sucrose.
Between 1.080—1.086=.164 per cent. sucrose.

3d. It is a noticeable fact that the "solids not sugar" increase regularly and with almost the same rapidity that the glucose diminishes. Thus, for the specific gravities between 1.030 and 1.086 the average percentage of glucose is 2.84, and of solids not sugar 2.71, while the actual loss of glucose is 2.76 per cent., and the actual gain of solids not sugar is 2.77 per cent. From the small number of ash determinations (34) it appears that the average percentage of ash in sorghum juice amounts to 1.07 per cent.; hence it appears that a loss of 2.76 per cent. of glucose is apparently counterbalanced by a gain of 1.70 per cent. of organic solids not sugar, the ash varying but slightly. These figures are subject to future revision, when a much larger number of ash determinations may render it possible to draw conclusions with greater safety.

One point, however, seems to be strongly suggested, namely, that the decrease in glucose bears a much closer relationship to the increase of organic solids not sugar than to the increase of crystallizable sugar. In other words, it seems at least possible that the commonly accepted idea that cane sugar is formed in plants only through the intervention of glucose may be a mistaken idea. This point is a very interesting one and worthy of careful study in the future.

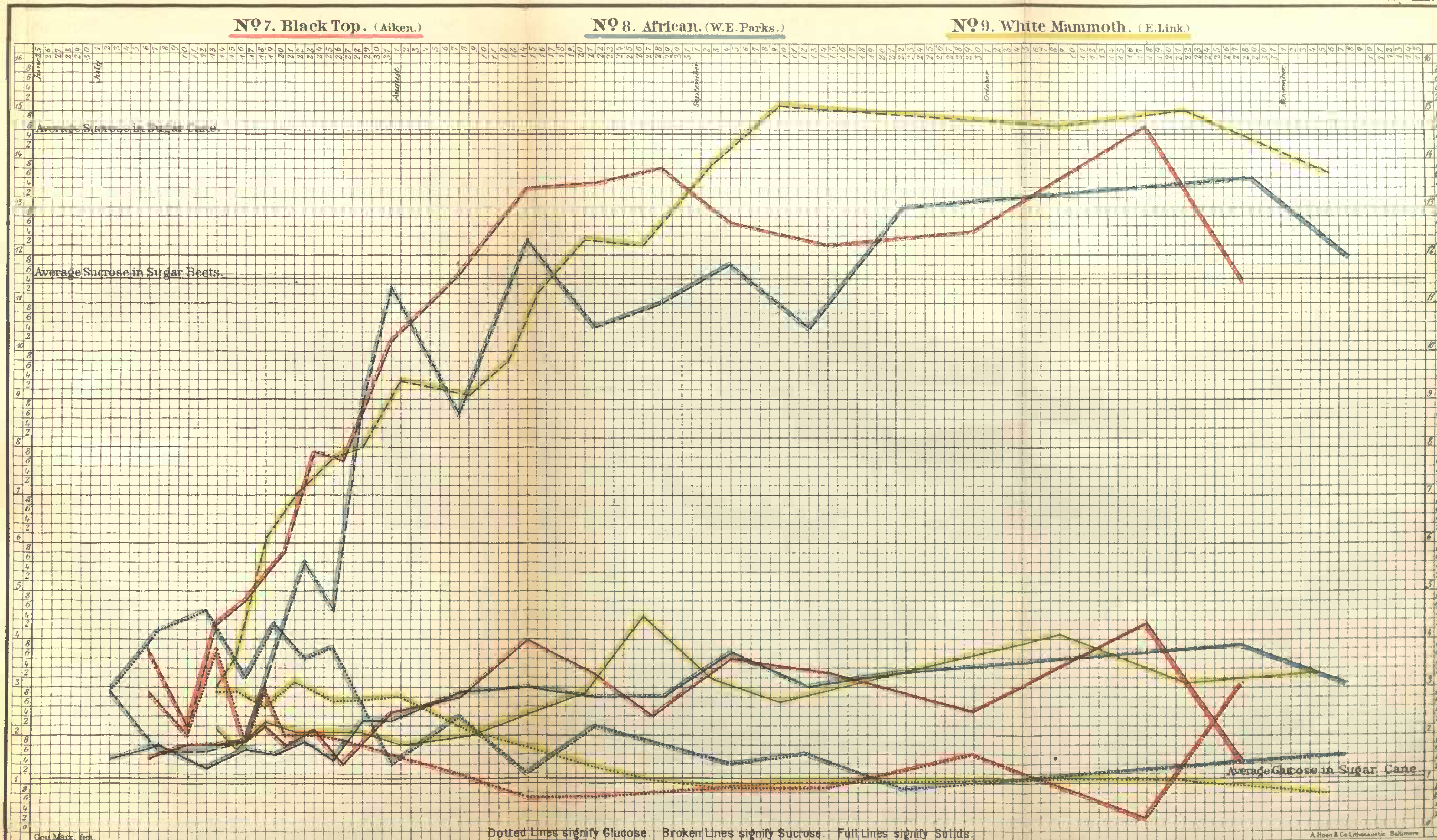
4th. The percentage of total solids regularly increases, with a few exceptions, with the increase of specific gravity; the average increase for each gain of .001 in specific gravity is 0.17 per cent. of total solids.

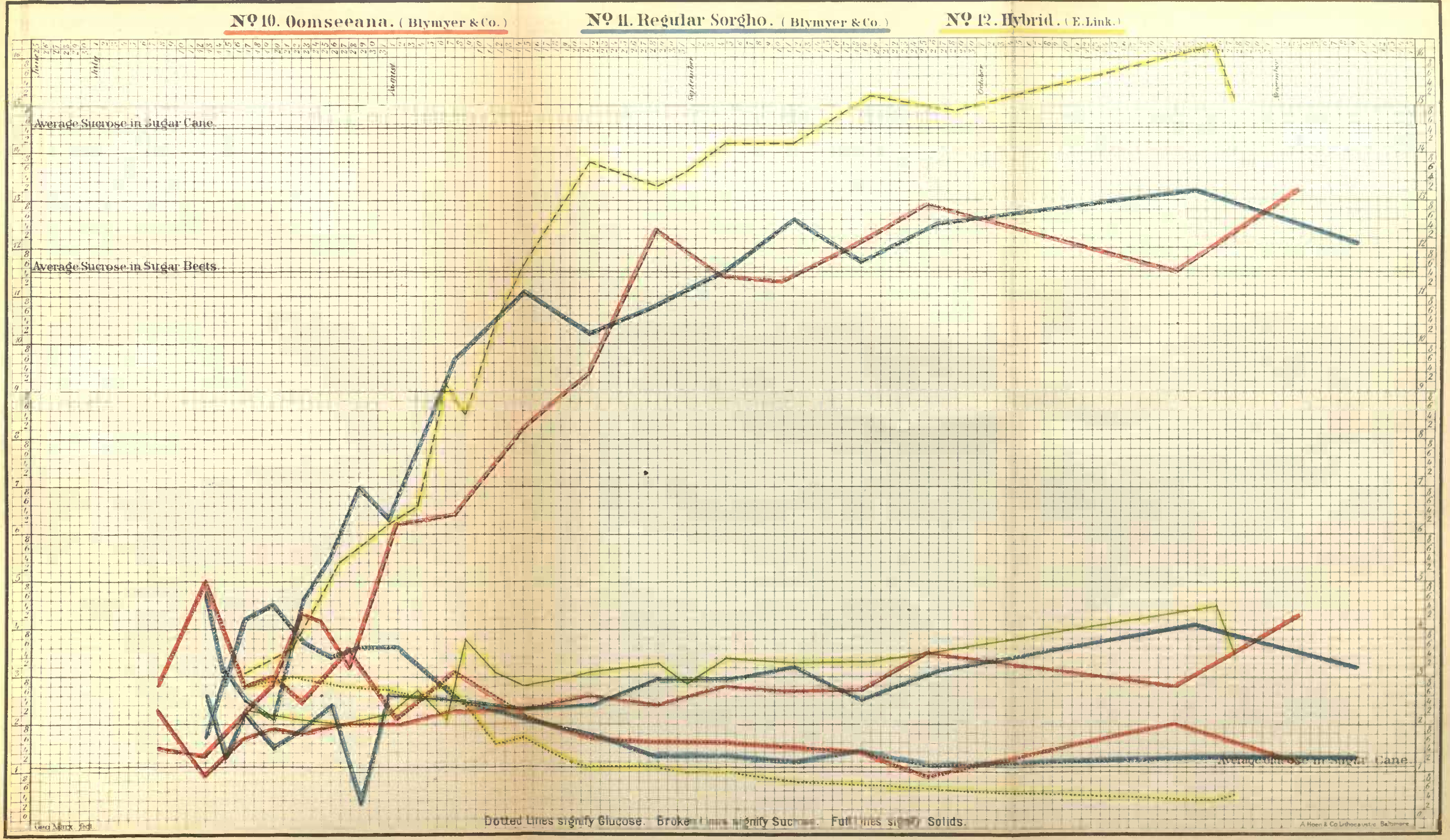
5th. Experience has shown that the percentage of crystallizable sugar in the total solids of the juice should exceed 70. in order that good results may be had.

An inspection of this table indicates that these juices attained that percentage (see column headed "Exponent") when the specific gravity 1.066 was reached, and this exponent was maintained, and even exceeded, until the specific gravity 1.086 was passed. After this the exponents are somewhat variable, because specific gravities above 1.086 were not attained until quite late in the season, when the plants had

Nº 1. Early Amber. (D. Smith.)
Nº 2. Early Amber. (Plant Seed Co.)
Nº 3. Early Golden. (A.B. Swain.)
June
July
August
September
October
November
Average Sucrose in Sugar Cane.
Average Sucrose in Sugar Beets.
Average Glucose in Sugar Cane.
Dotted Lines signify Glucose. Broken Lines signify Sucrose. Full Lines signify Solids.
Geo. Marx. Fecit.
A. Hoen & Co. Lithocaustic Baltimore

Nº 4. Golden Syrup. (W.H. Lytle.)
Nº 5. White Liberian. (D. Smith.)
Nº 6. Early Amber. (Evans.)
June
July
August
September
October
November
Average Sucrose in Sugar Cane.
Average Sucrose in Sugar Beets.
Average Glucose in Sugar Cane.
Dotted Lines signify Glucose. Broken Lines signify Sucrose. Full Lines signify Solids.
A. Hoen & Co. Lithocaustic Baltimore


No. 7. Black Top. (Aiken.)
No. 8. African. (W. E. Parks.)
No. 9. White Mammoth. (E. Link.)
June
July
August
September
October
November
Average Sucrose in Sugar Cane.
Average Sucrose in Sugar Beets.
Average Glucose in Sugar Cane.
Dotted Lines signify Glucose. Broken Lines signify Sucrose. Full Lines signify Solids.
Geo. Mark. fecit.
A. Hoen & Co. Lithocaustic. Baltimore.


Nº 10. Oomseeana. (Blymyer & Co.)
Nº 11. Regular Sorgho. (Blymyer & Co.)
Nº 12. Hybrid. (E. Link.)
June
July
August
September
October
November
Average Sucrose in Sugar Cane.
Average Sucrose in Sugar Beets.
Average Glucose in Sugar Cane.
Dotted Lines signify Glucose. Broken Lines signify Sucrose. Full Lines signify Solids.
Geo. Marx. Del.
A. Hoen & Co. Lithocaustic Baltimore

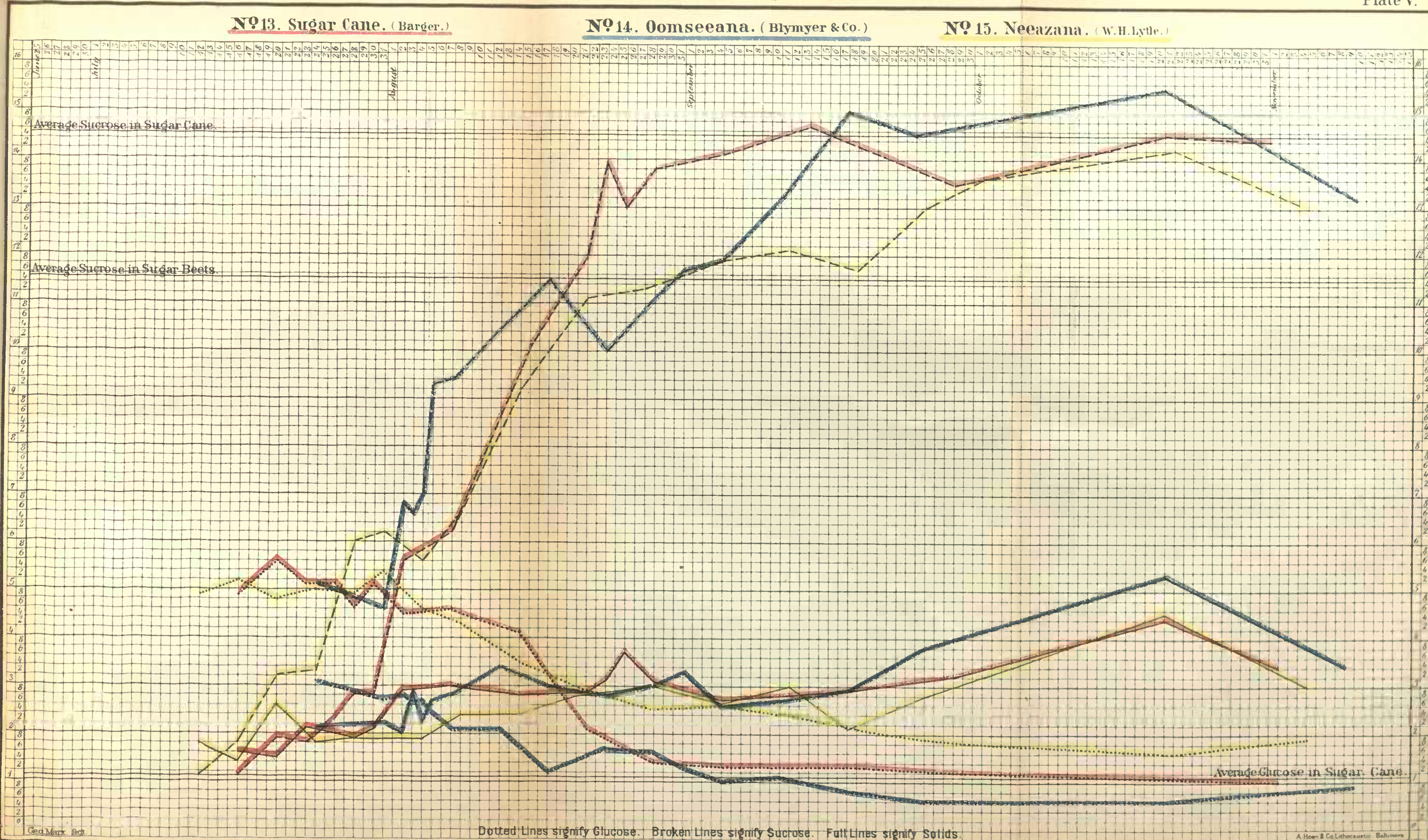
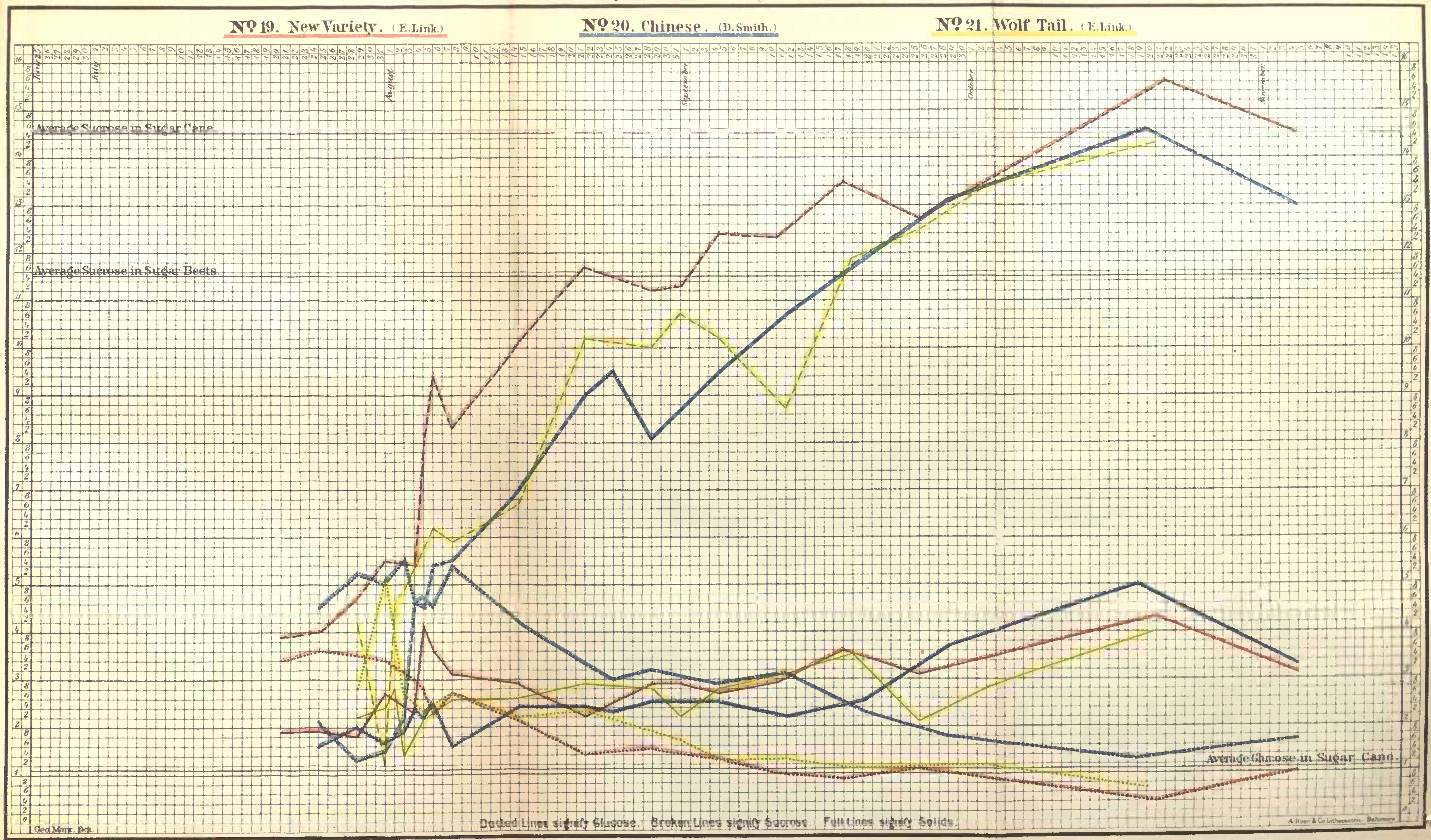
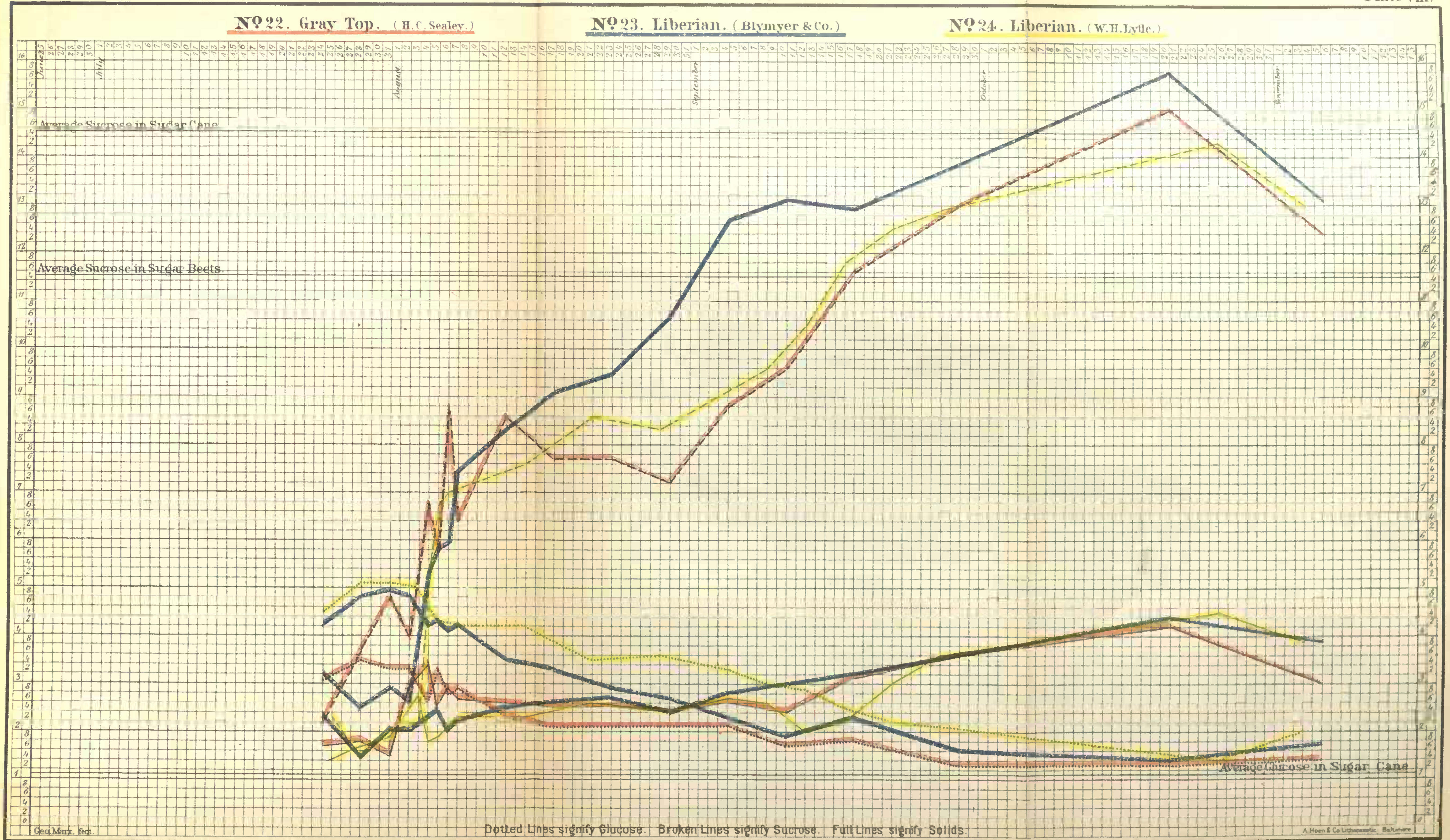

No. 13. Sugar Cane. (Barger.)
No. 14. Oomseeana. (Blymyer & Co.)
No. 15. Neeazana. (W. H. Lytle.)
July
August
September
October
November
Average Sucrose in Sugar Cane.
Average Sucrose in Sugar Beets.
Average Glucose in Sugar Cane.
Dotted Lines signify Glucose. Broken Lines signify Sucrose. Full Lines signify Solids.
Geo. Marx fecit.
A. Hoen & Co. Lithocaustic, Baltimore.

Plate VI.

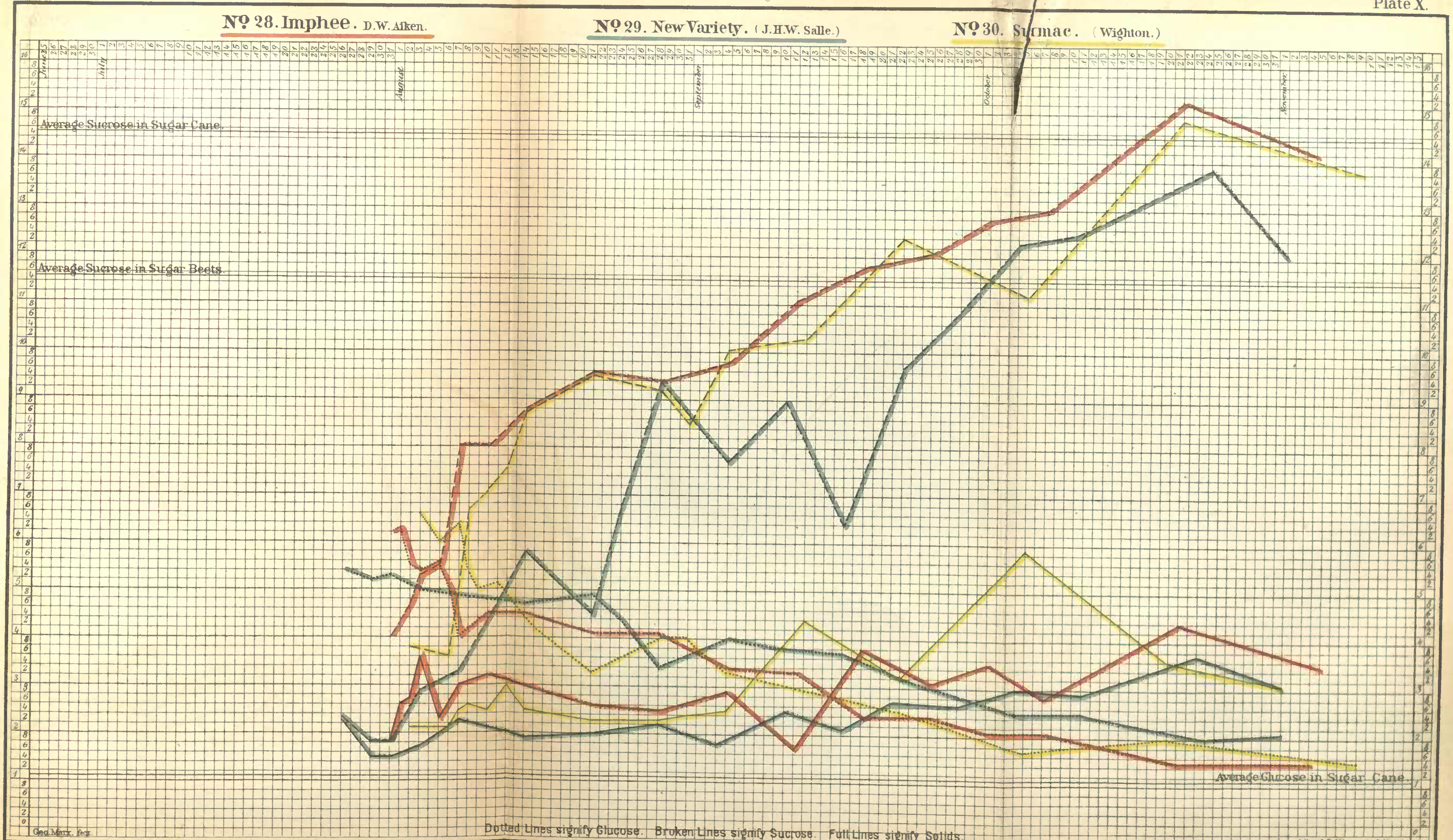

Nº 16. Goose Neck. (P.P. Ramsey.)
Nº 17. Early Orange. (I.A. Hedges.)
Nº 18. Neeazana. (Blymyer & Co.)
June
July
August
September
October
November
Average Sucrose in Sugar Cane.
Average Sucrose in Sugar Beets.
Average Glucose in Sugar Cane.
Dotted Lines signify Glucose. Broken Lines signify Sucrose. Full Lines signify Solids.
Geo. Marx, Del.
A. Hoen & Co. Lithocaustic Baltimore


No. 19. New Variety. (E. Link.)
No. 20. Chinese. (D. Smith.)
No. 21. Wolf Tail. (E. Link.)
June
July
August
September
October
November
Average Sucrose in Sugar Cane.
Average Sucrose in Sugar Beets.
Average Glucose in Sugar Cane.
Dotted Lines signify Glucose. Broken Lines signify Sucrose. Full Lines signify Solids.
Geo. Marx. fecit.
A. Hoen & Co. Lithocaustic, Baltimore.

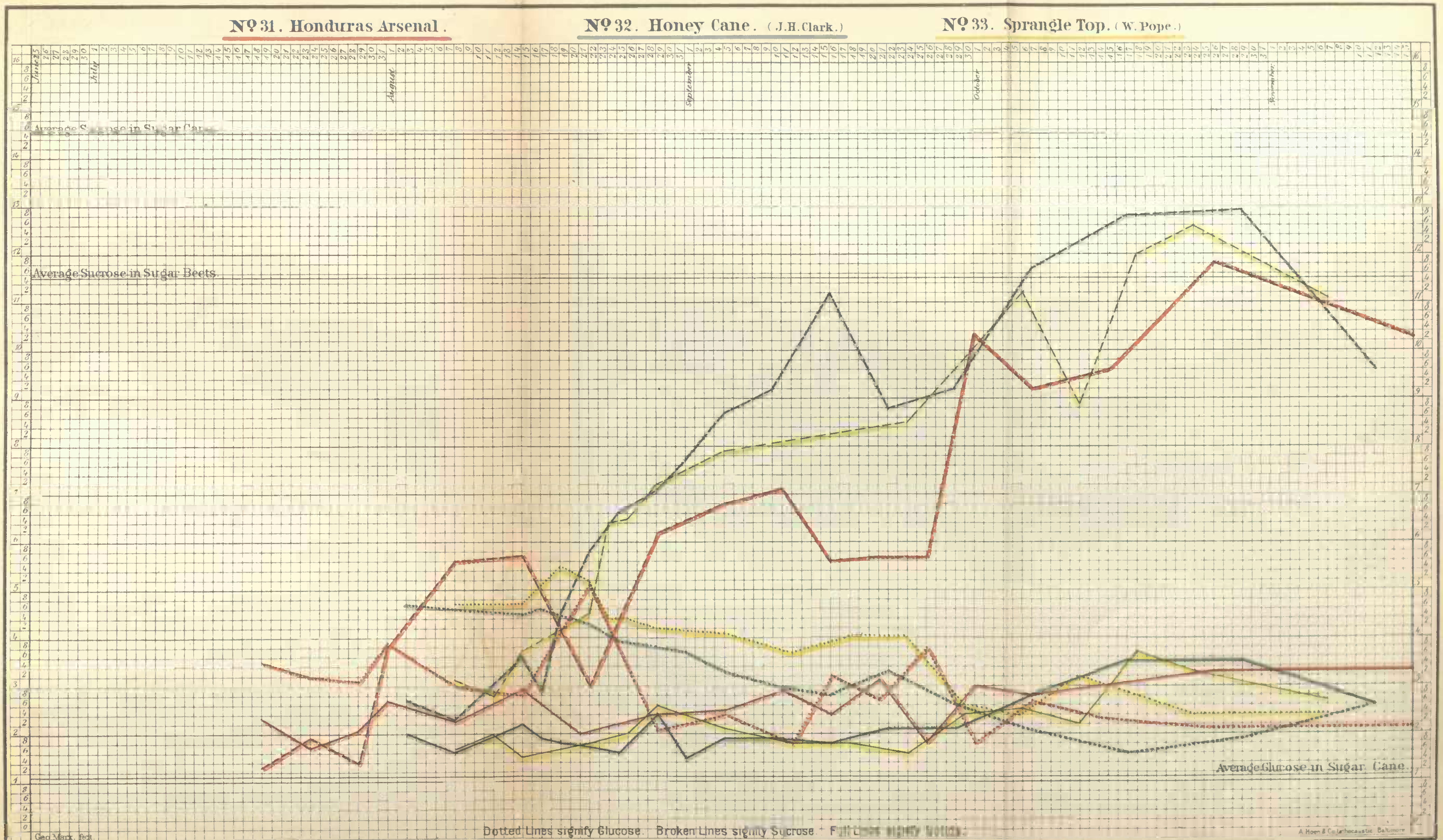

No. 22. Gray Top. (H. C. Sealey.)
No. 23. Liberian. (Blymyer & Co.)
No. 24. Liberian. (W. H. Lytle.)
July
August
September
October
November
Average Sucrose in Sugar Cane.
Average Sucrose in Sugar Beets.
Average Glucose in Sugar Cane.
Geo. Marx. fecit.
Dotted Lines signify Glucose. Broken Lines signify Sucrose. Full Lines signify Solids.
A. Hoen & Co. Lithocaustic. Baltimore.

Nº 25. Oomseeana. (Mayes & Co.)
Nº 26. Sumac. (W. Pope.)
Nº 27. Mastodon. (D.W. Aiken.)
June
July
August
September
October
November
Average Sucrose in Sugar Cane.
Average Sucrose in Sugar Beets
Average Glucose in Sugar Cane
Dotted Lines signify Glucose. Broken Lines signify Sucrose. Full Lines signify Solids.
Geo Marx, fect.
A. Hoen & Co. Lithocaustic, Baltimore

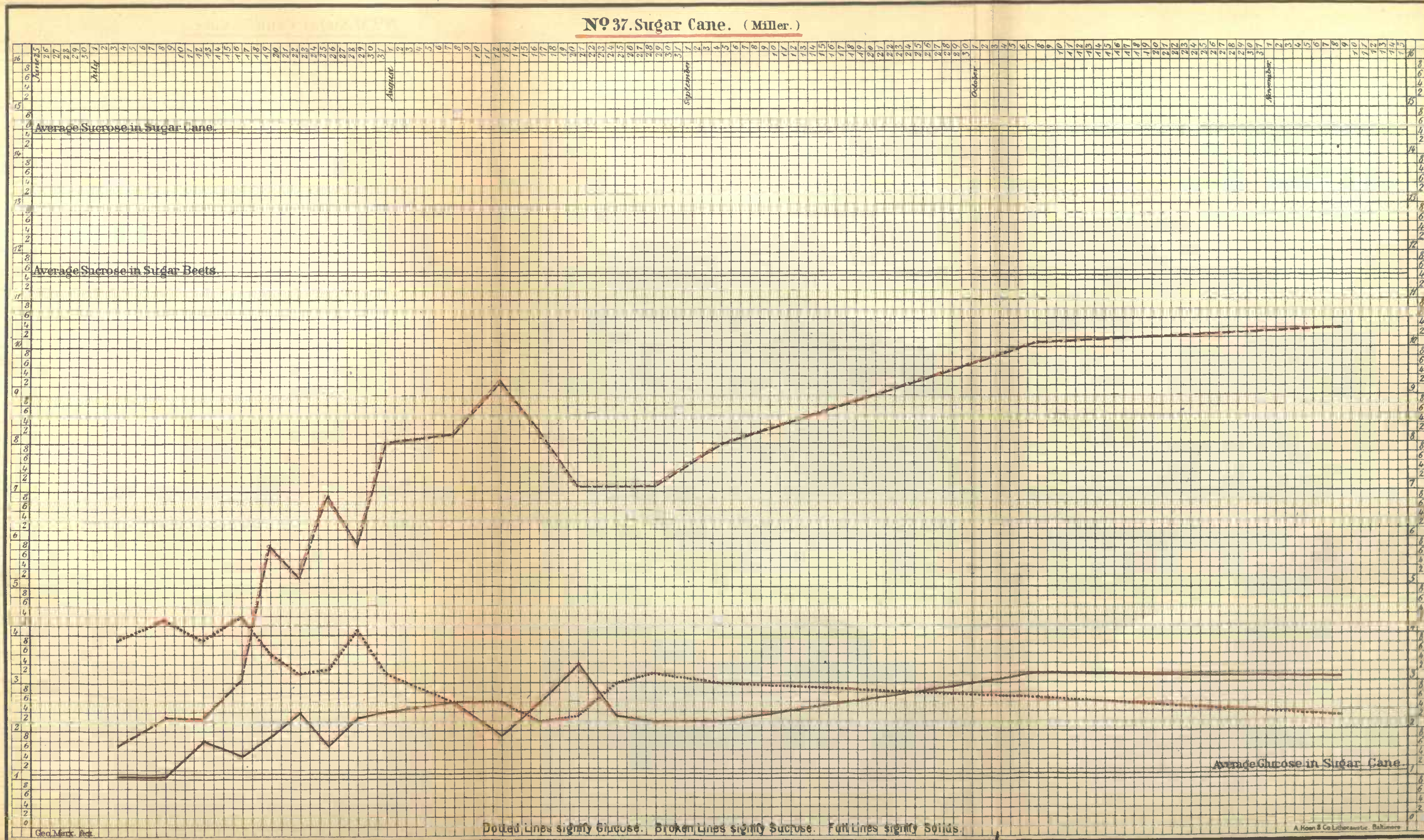
Plate X.



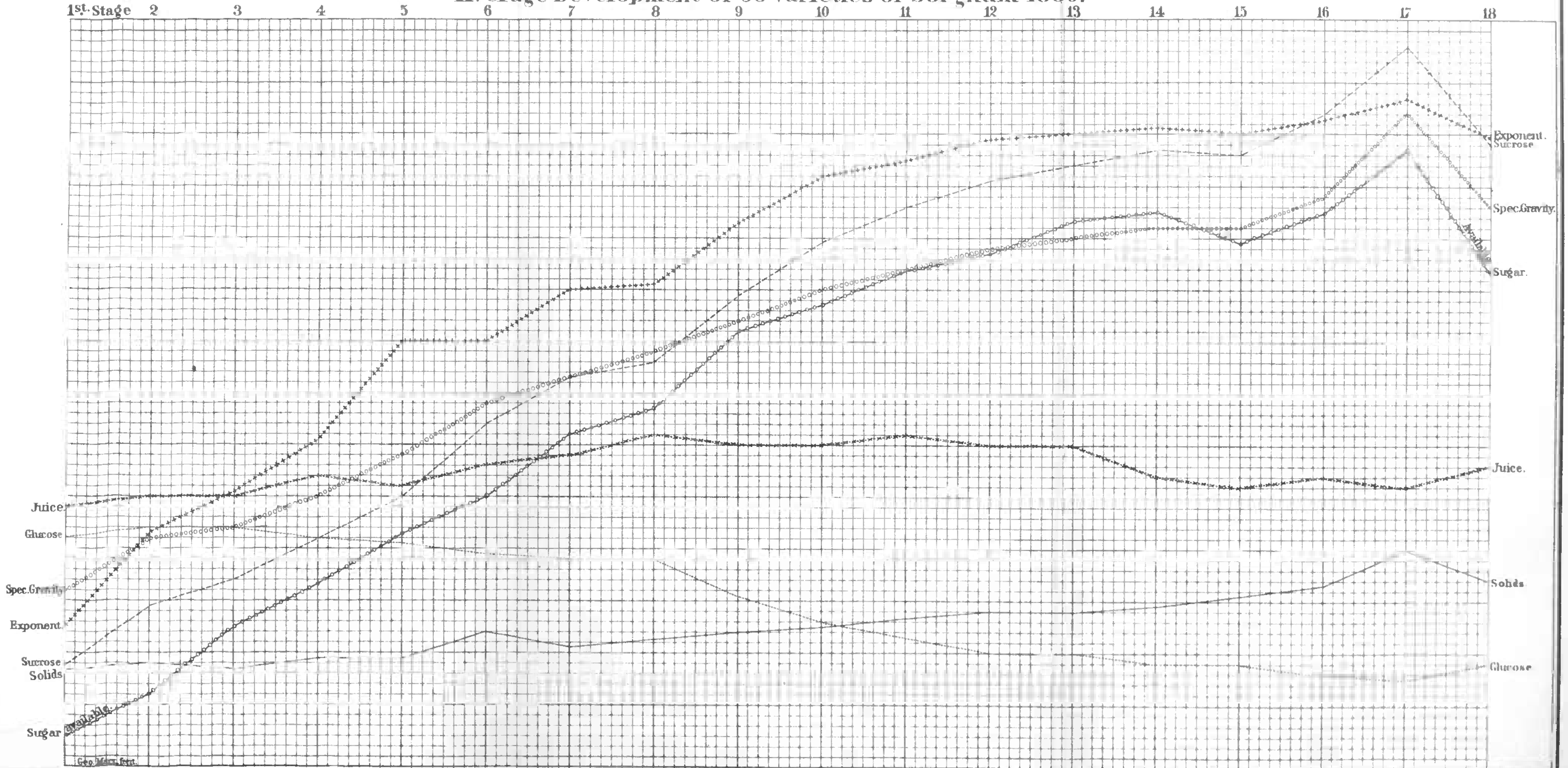
No. 28. Imphee. D. W. Aiken.
No. 29. New Variety. (J. H. W. Salle.)
No. 30. Sumac. (Wighton.)
June
July
August
September
October
November
Average Sucrose in Sugar Cane.
Average Sucrose in Sugar Beets.
Average Glucose in Sugar Cane.
Dotted Lines signify Glucose. Broken Lines signify Sucrose. Full Lines signify Solids.
Geo. Marx, fecit.
A. Hoen & Co. Lithocaustic, Baltimore.


No. 31. Honduras Arsenal.
No. 32. Honey Cane. (J. H. Clark.)
No. 33. Sprangle Top. (W. Pope.)
June
July
August
September
October
November
Average Sucrose in Sugar Cane.
Average Sucrose in Sugar Beets.
Average Glucose in Sugar Cane.
Dotted Lines signify Glucose. Broken Lines signify Sucrose. Full Lines signify Solids.
Geo. Marx, fecit.
A. Hoen & Co. Lithocaustic, Baltimore.


Nº 34. Honduras (E. Link.)
Nº 35. Honey Top or Texas Cane.
Nº 36. Honduras (Brande.)
June
July
August
September
October
November
Average Sucrose in Sugar Cane.
Average Sucrose in Sugar Beets.
Average Glucose in Sugar Cane.
Dotted Lines signify Glucose. Broken Lines signify Sucrose. Full Lines signify Solids.
Geo. Marx. fecit.
A. Hoen & Co. Lithocaustic. Baltimore.


No. 37. Sugar Cane. (Miller.)
June
July
August
September
October
November
Average Sucrose in Sugar Cane.
Average Sucrose in Sugar Beets.
Average Glucose in Sugar Cane.
Dotted Lines signify Glucose. Broken Lines signify Sucrose. Full Lines signify Solids.
Geo. Marx. Del.
A. Hoen & Co. Lithocaustic. Baltimore.

Average Development of 38 Varieties of Sorghum 1880.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Sugar pr. Acre	77.	186.	248.	363.	534.	674.	870.	939.	1201.	1441.	1580.	1662.	1697.	1728.	1667.	1739.	1967.	1724.
No. of Analyses	59.	70.	58.	72.	77.	64.	70.	111.	266.	217.	166.	170.	183.	191	217.	339.	197.	191
Sucrose %	1.74.	293.	3.47.	4.29.	5.06.	6.40.	7.38.	7.69.	8.95.	9.98.	10.66.	11.18.	11.40.	11.76	11.69	12.40.	13.72.	11.92
Glucose %	4.26.	4.44.	4.45.	4.28.	4.11.	3.94.	3.86.	3.83.	3.19.	2.60.	2.35.	2.07.	2.03.	1.88	1.81.	1.64	1.56	1.85
Solids %	1.73.	1.86.	1.79.	1.92.	1.97.	2.45.	2.19.	2.37.	2.42.	2.50.	2.72.	2.83.	2.82.	2.96.	3.15.	3.32	4.07.	3.42
Juice %	58.72.	59.52.	59.58.	61.58.	63.00.	62.60.	63.84.	65.65.	64.96.	64.94.	65.04.	63.62.	63.14.	61.72	60.45.	61.20	60.17	62.09
Spec. Gravity	1031.	1036.	1037.	1040.	1044.	1049.	1052.	1055.	1058.	1061.	1063.	1065.	1066.	1067.	1067.	1070.	1078	1069
Exponent %	22.51.	31.74.	35.74.	40.89.	49.90.	50.04.	54.95.	55.36.	61.47.	66.18.	67.77.	69.53.	70.15.	70.84.	70.21.	71.43	70.90	69.34

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nearly or quite ceased growing; also, the number of experiments for these higher specific gravities was smaller than for the lower figures. It is safe to say that the profitable working period for sorghum canes begins when the juice attains the specific gravity 1.066, and continues until the specific gravity 1.086 is reached, and frequently even longer. During this period the canes here examined furnished on an average 61.9 per cent. of juice from the stripped stalks. A good mill should furnish not less than 60 per cent. on the large scale. Several manufacturers are willing to contract for mills to furnish 65 per cent.

6th. On the supposition that a good mill, yielding at least 60 per cent. of juice from the stripped stalks, is used, the amount of sugar which should be obtained from 100 pounds of stalks is found by referring to the figures in the last column corresponding with the specific gravity of the juice obtained. For example, each 100 pounds of stripped stalks, the juice from which has the specific gravity 1.073, should actually furnish 5.51 pounds of cane sugar. Even better results than these have actually been obtained in several instances. In the same manner the yield of sugar can be calculated from the weight of the juice by reference to the figures under the heading "Available percentage of sucrose in juice."

TABLE No. 89.

Specific gravity.	Per cent. of juice.	Per cent. of glucose.	Per cent. of sucrose.	Per cent. of solids not sugar.	Total solids in juice.	Exponent.	Available per cent. sucrose in juice.	Available per cent. sucrose in stripped stalks at 60 per cent. juice.	Number of analyses.
1.019	61.32	.67	2.20	3.12	5.99	36.73	.81	.48	1
1.021	58.30	3.91	.54	.68	5.13	10.53	.06	04	2
1.022	69.04	3.06	1.46	1.11	5.63	25.93	.38	23	1
1.023	47.36	3.27	1.15	1.29	5.71	20.14	.23	.14	3
1.024	60.49	3.85	1.02	1.73	6.60	15.45	.16	.10	1
1.026	62.78	4.04	.98	.91	5.93	16.53	.16	.10	1
1.027	57.08	3.41	2.09	1.61	7.11	29.40	.61	.37	3
1.028	46.61	3.98	1.79	2.34	8.11	22.07	.40	.24	8
1.029	57.72	4.34	1.55	1.53	7.42	20.89	.33	.20	6
1.030	45.44	3.98	2.36	1.82	8.16	28.92	.58	.35	11
1.031	56.01	3.82	2.66	1.58	8.06	33.00	.88	.53	12
1.032	60.97	3.95	2.16	2.05	8.16	26.47	.57	.34	17
1.033	60.13	4.52	2.26	1.78	8.56	26.40	.60	.36	28
1.034	66.96	4.24	2.50	1.93	8.67	28.84	.72	.43	13
1.035	60.22	4.11	3.29	1.98	9.38	35.08	1.15	.69	23
1.036	64.28	4.56	3.12	1.59	9.27	33.66	1.05	.63	23
1.037	60.12	4.42	3.56	1.75	9.73	36.59	1.30	.78	25
1.038	61.37	4.43	3.43	1.88	9.74	35.22	1.21	.73	21
1.039	61.30	4.14	4.00	1.85	9.99	40.00	1.60	.96	25
1.040	62.78	3.94	4.41	1.77	10.17	43.36	1.91	1.15	18
1.041	62.41	4.21	4.30	1.92	10.43	41.23	1.77	1.06	26
1.042	59.40	4.13	4.69	1.91	10.73	43.71	2.05	1.23	23
1.043	64.72	4.26	4.95	1.92	11.13	44.48	2.20	1.32	22
1.044	63.98	3.79	5.23	2.17	11.19	46.74	2.42	1.45	17
1.045	61.54	3.87	5.51	2.19	11.47	48.04	2.65	1.59	24
1.046	64.34	3.76	5.72	2.10	11.58	49.34	2.82	1.69	30
1.047	65.03	3.43	6.28	2.15	11.86	52.95	3.33	2.00	31
1.048	65.18	3.99	6.08	2.03	12.10	50.25	3.06	1.84	36
1.049	62.88	3.62	6.34	2.23	12.19	52.01	3.30	1.98	37
1.050	66.17	3.32	6.99	2.29	12.60	55.48	3.88	2.33	48
1.051	62.81	3.12	7.18	2.26	12.56	57.17	4.10	2.46	42
1.052	64.36	3.18	7.64	2.46	13.28	57.61	4.40	2.64	43
1.053	63.95	3.42	7.58	2.31	13.31	56.95	4.32	2.59	43
1.054	63.33	3.12	7.74	2.27	13.13	58.95	4.57	2.74	49
1.055	65.66	3.38	8.12	2.24	13.74	59.09	4.80	2.88	55
1.056	63.66	2.93	8.61	2.40	13.97	61.63	4.92	2.95	52
1.057	62.74	2.99	8.90	2.34	14.23	62.54	5.57	3.34	56
1.058	64.10	2.78	9.18	2.53	14.49	63.35	5.82	3.49	76

TABLE No. 89—Continued.

Specific gravity.	Per cent. of juice.	Per cent of glucose.	Per cent. of sucrose.	Per cent. of solids not sugar.	Total solids in juice.	Exponent.	Available per cent. sucrose in juice.	Available per cent. sucrose in stripped stalks at 60 per cent. juice.	Number of analyses.
1.059	63.93	3.05	9.28	2.44	14.77	62.90	5.84	3.50	53
1.060	63.15	2.65	9.80	2.67	15.12	64.81	6.35	3.81	100
1.061	64.86	2.73	9.88	2.75	15.36	64.32	6.36	3.82	76
1.062	63.35	2.51	10.24	2.77	15.52	65.98	6.76	4.06	73
1.063	64.74	2.65	10.16	2.95	15.76	64.47	6.55	3.93	84
1.064	63.48	2.43	10.64	2.95	16.02	66.42	7.07	4.24	64
1.065	61.08	2.07	11.19	2.85	16.11	69.46	7.77	4.66	81
1.066	63.58	2.08	11.46	2.72	16.26	70.48	8.08	4.85	74
1.067	60.98	1.99	11.80	2.87	16.66	70.83	8.36	5.02	69
1.068	63.25	1.97	11.84	3.00	16.81	70.43	8.34	5.00	56
1.069	61.15	1.81	12.30	3.05	17.16	71.68	8.82	5.29	75
1.070	63.45	1.84	12.59	3.00	17.43	72.23	9.09	5.45	82
1.071	62.37	1.81	12.54	3.26	17.61	71.21	8.93	5.36	89
1.072	61.81	1.68	12.94	3.21	17.83	72.58	9.39	5.63	82
1.073	62.46	1.85	12.83	3.20	17.88	71.76	9.19	5.51	75
1.074	61.44	1.69	13.22	3.37	18.28	72.32	9.56	5.74	75
1.075	61.78	1.71	13.47	3.37	18.55	72.62	9.78	5.87	67
1.076	61.49	1.47	13.66	3.54	18.67	73.16	9.99	5.99	68
1.077	60.41	1.62	13.75	3.58	18.95	72.56	9.98	5.99	45
1.078	61.18	1.50	13.88	4.04	19.42	71.47	9.92	5.95	52
1.079	60.80	1.51	14.01	3.67	19.19	73.01	10.23	6.14	46
1.080	60.00	1.57	14.01	3.74	19.32	72.52	10.16	6.08	41
1.081	60.58	1.43	14.24	4.10	19.77	72.03	10.26	6.16	25
1.082	60.47	1.14	15.06	4.05	20.25	74.37	11.20	6.72	25
1.083	59.71	1.50	14.71	4.23	20.44	71.97	10.59	6.35	29
1.084	59.27	1.48	14.84	4.13	20.45	72.56	10.77	6.46	17
1.085	60.07	1.22	15.14	4.56	20.92	72.37	10.96	6.58	12
1.086	58.74	1.22	15.65	4.59	21.46	72.92	11.41	6.85	14
1.087	53.68	2.35	13.83	4.38	20.56	67.26	9.30	5.58	3
1.088	59.08	1.38	15.32	4.69	21.40	71.59	10.87	6.52	9
1.089	57.72	.80	16.25	6.32	23.37	69.53	11.30	6.78	1
1.090	55.57	1.19	15.87	4.78	21.84	72.66	11.53	6.92	3
1.092	54.55	2.75	14.76	4.70	22.21	66.45	9.81	5.89	1

COMPARISON OF DIFFERENT HYDROMETERS.

In taking the specific gravity of solutions containing sugar there are now used various hydrometers which are graduated in different ways. This naturally leads to considerable confusion, and it has been thought best to here append a table (No. 90) which shall show the comparative values of the different scales. It is always preferable in this work to use a hydrometer which shows the actual specific gravity of the juice, but those who have either the Baumé or Brix hydrometers can, by use of this table, make them answer every purpose. It will be noticed that the specific gravity 1.066, which was recommended as the proper indication that the juice was in a workable condition, corresponds exactly with 16° Brix and 9.° Baumé.

TABLE No. 90.—*Specific gravity equivalents of the Brix and Beaumé scales.*

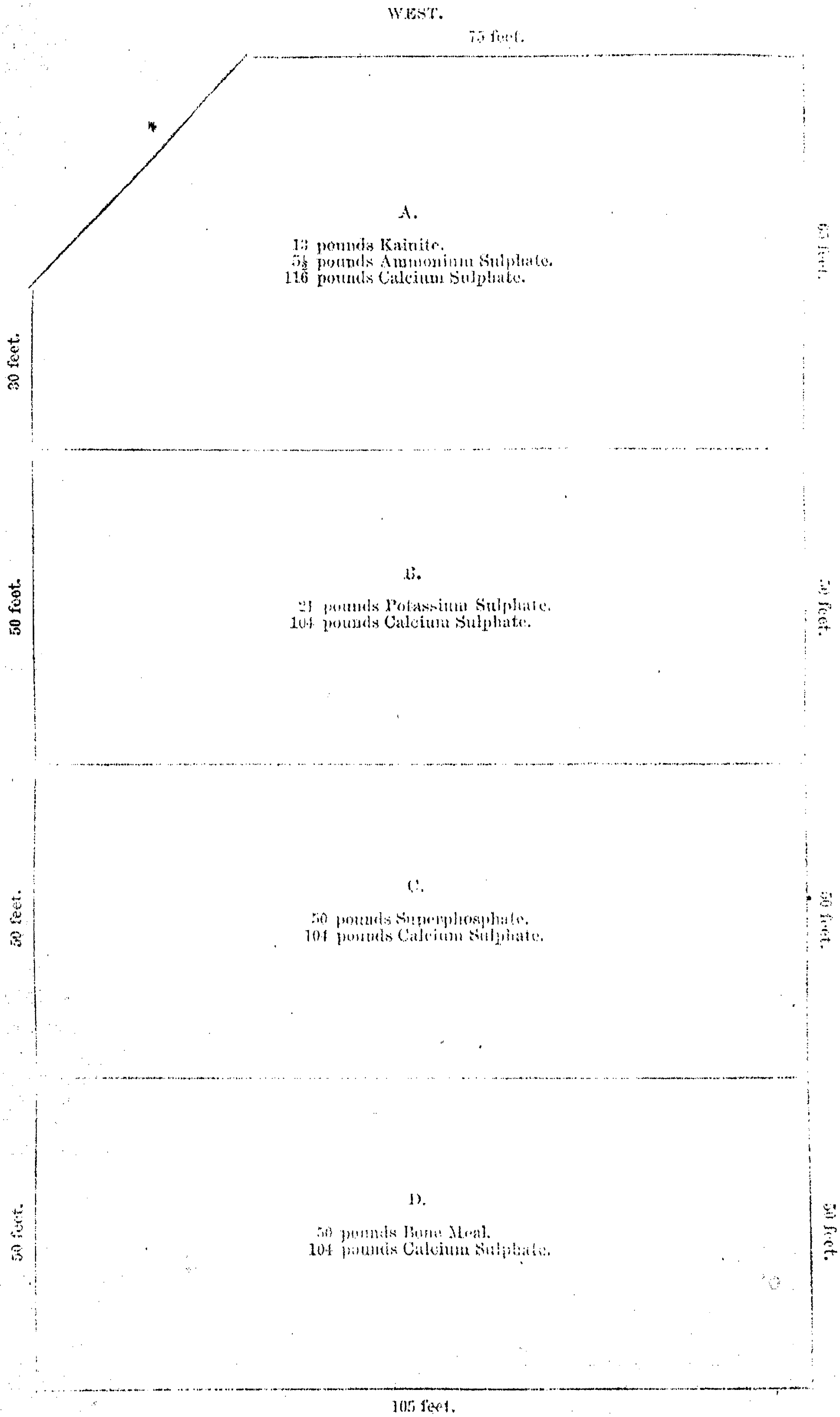
Specific gravity.	Degree Brix.	Degree Beaumé.	Specific gravity.	Degree Brix.	Degree Beaumé.	Specific gravity.	Degree Brix.	Degree Beaumé.
1.000	0.	0.0	1.094	22.5	....	1.203	44.5	....
.002	.5	....	.097	23.	....	.206	45.	....
.004	1.	....	.099	23.5	13.0	.208	45.5	....
.006	1.5	....	.101	24.	....	.211	46.	25.0
.008	2.	1.0	.103	24.5	....	.214	46.5	....
.010	2.5	....	.106	25.	....	.216	47.	....
.012	3.	....	.108	25.5	14.0	.219	47.5	....
.014	3.5	2.0	.111	26.	....	.222	48.	26.0
.016	4.	....	.113	26.5	....	.225	48.5	....
.018	4.5	....	.115	27.	15.0	.227	49.	....
.020	5.	....	.118	27.5	....	.230	49.5	27.0
.022	5.5	3.0	.120	28.	....	.233	50.	....
.024	6.	....	.123	28.5	....	.236	50.5	....
.026	6.5	....	.125	29.	16.0	.238	51.	....
.028	7.	4.0	.127	29.5	....	.241	51.5	28.0
.030	7.5	....	.130	30.	....	.244	52.	....
.032	8.	....	.132	30.5	....	.247	52.5	....
.034	8.5	....	.134	31.	17.0	.250	53.	....
.036	9.	5.0	.137	31.5	....	.252	53.5	29.0
.038	9.5	....	.139	32.	....	.255	54.	....
.040	10.	....	.142	32.5	....	.258	54.5	....
.042	10.5	....	.144	33.	18.0	.261	55.	....
.044	11.	6.0	.147	33.5	....	.264	55.5	30.0
.046	11.5	....	.149	34.	....	.267	56.	....
.048	12.	....	.152	34.5	19.0	.269	56.5	....
.050	12.5	7.0	.154	35.	....	.272	57.	....
.053	13.	....	.157	35.5	....	.275	57.5	31.0
.055	13.5	....	.159	36.	....	.278	58.	....
.057	14.	....	.162	36.5	20.0	.281	58.5	....
.059	14.5	8.0	.164	37.	....	.284	59.	....
.061	15.	....	.167	37.5	....	.287	59.5	32.0
.063	15.5	....	.169	38.	....	.290	60.	....
.066	16.	9.0	.172	38.5	21.0	.293	60.5	....
.068	16.5	....	.174	39.	....	.296	61.	....
.070	17.	....	.177	39.5	....	.299	61.5	33.0
.072	17.5	....	.179	40.	22.0	.302	62.	....
.074	18.	10.0	.182	40.5	....	.305	62.5	....
.076	18.5	....	.185	41.	....	.308	63.	34.0
.079	19.	....	.187	41.5	....	.311	63.5	....
.081	19.5	....	.190	42.	23.0	.314	64.	....
.083	20.	11.0	.192	42.5	....	.317	64.5	....
.085	20.5	....	.195	43.	....	.320	65.	35.0
.088	21.	....	.198	43.5	....	.323	65.5	....
.090	21.5	12.0	.200	44.	24.0	.326	66.	....
.092	22.	....						

EFFECTS OF FERTILIZERS ON SUCROSE, GLUCOSE, AND SOLIDS IN SORGHUM JUICES.

The three tables which follow represent 634 analyses made for the purpose of determining what, if any, differences in the composition of sorghum juices are caused by the use of different fertilizing materials.

In order to give a more perfect understanding of the circumstances under which these experiments were conducted, there are here appended analyses of the soil and the special fertilizers applied, together with diagrams showing the exact shape and dimensions of each experimental plot.

Sorghum plot, Department Grounds.



Analysis of soil upon sorghum plot before applying fertilizers.

	Per cent.
Moisture	1.740
Organic matter	4.980
Carbonic acid	.200
Insoluble in acids	84.235
Ferric oxide	2.864
Alumina	4.416
Lime	.635
Magnesia	.400
Phosphoric acid	.198
Potash	.100
Soda	.054
Sulphuric acid	.024
	99.846

Analysis of fertilizers used upon sorghum plot.

Superphosphate of lime:

	Per cent.
Soluble phosphoric acid	9.77
Insoluble phosphoric acid	3.63
Reverted phosphoric acid	.69
Nitrogen (= NH_3 2.45 per cent)	2.02

Commercial kainite:

	Per cent.
Potassium sulphate	24.74
Sodium sulphate	18.92
Sodium chloride	15.54

Bone meal:

	Per cent.
Phosphoric acid	21.96
Nitrogen (= NH_3 5.22 per cent)	4.30

Sulphate of ammonia:

	Per cent.
Pure ammonium sulphate	98.39
Sulphuric acid (SO_3)	59.63
Ammonia (NH_3)	25.34

Sulphate of potash:

	Per cent.
Pure potassium sulphate	98.79
Potash (K_2O)	53.37
Sulphuric acid (SO_3)	45.42

An inspection of the analysis of the soil shows it to be exceptional in its very small content of lime, and in the almost entire absence of chlorine. It is, in fact, a gravelly soil which has been highly cultivated and very considerably changed in its character. Its present need seems chiefly to be the addition of sulphate of lime ("land plaster" or gypsum).

The superphosphate was such as is commonly sold in this vicinity; it was a good article, but not of the highest grade. The same may be said of the kainite. The other fertilizers were of higher grade. It was thought best to show the effect of each fertilizer on each cane in the various stages of its growth. For this purpose the results are classified in the three tables to correspond with a content of sucrose; in the first set below 5 per cent., in the second set of 5 to 10 per cent., in the third set of 10 to 15 per cent., and in the fourth set above 15 per cent. It will be understood that the results embraced in the third and fourth sets are those attained during the period when most of the canes were in the best condition for working; those in the first and second sets are equally valuable as helps in settling the effect of the fertilizers on the immature

growing cane; while the final averages must, after all, give the most accurate general idea as to the effect of each fertilizer on each cane during the whole season.

We do not feel warranted in drawing any definite conclusions from these final averages; the close agreement between the averages drawn from so many results seems to point to the fact that the soil originally contained sufficient food for the proper development of the sorghum plants, and that the addition of these special fertilizers was unnecessary and resulted in no marked change in the composition of the sorghum juices. In fact the analyses made a year ago showed the canes to have the same composition as they have this year been found to have, and equally large crops of four varieties of sorghum were then obtained. These results must not be taken to prove, however, that on certain soils, which are deficient in one or more essential constituents of plant food, the addition of proper fertilizers will not be of great value. Certainly such additions to poor soils are likely to increase the crop; whether the quality of the juice will be improved must yet be decided.

TABLE No. 91.—*Average Sucroses.*

Number of cane.	First set.—Average sucrose below 5 per cent.				Second set.—Average sucrose 5 to 10 per cent.				Third set.—Average sucrose 10 to 15 per cent.				Fourth set.—Average sucrose over 15 per cent.				Final averages.—Average sucrose for each cane.				Number of analyses.
	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	
1					8.41				12.04	12.09	12.34	12.41					11.87	12.09	12.34	12.41	20
2					9.17	9.02	11.82	7.84	11.66	11.54	10.84	12.01					11.28	11.30	10.90	11.78	19
3					8.17	8.42	10.55	9.55	11.54	12.02	11.31	11.03					11.06	11.64	11.18	10.78	19
4					10.62	11.06	7.22	7.44	11.89	12.50	12.36	11.57					11.61	12.34	11.75	11.11	18
5			2.20		8.62	7.62			13.18	12.70	12.57	13.35				15.20	12.80	12.24	11.62	13.51	11
6									12.41	12.51			16.31	15.07			12.73	12.73			12
7									12.71	13.03			15.45				12.91	13.03			13
8									12.33	12.40	12.10	12.10					12.33	12.40	12.10	12.10	19
9					8.66	9.04	8.47	8.19	13.14	12.60	13.53	13.41	15.30	14.91	15.09	16.15	12.17	11.41	12.68	12.56	13
10					6.20	9.67	9.50	8.50	12.39	12.27	12.59	12.45					10.92	11.58	11.68	11.29	19
11					9.15	9.06	10.70	7.67	12.24	12.23	11.95	12.35					11.95	11.90	11.81	11.86	19
12											13.67	13.62			15.64	15.48			14.45	14.42	15
13											13.36	14.08			15.19				13.50	14.08	14
14							8.23	11.43			12.25	13.16			15.24	15.43			12.48	13.51	17
15					9.08	9.86	8.75	8.66	12.61	12.84	12.42	12.40					12.28	12.51	11.99	11.98	19
16					9.38	8.27	8.58	8.84	12.41	11.52	11.58	12.33	15.20		15.00	15.13	12.16	10.98	11,22	11.98	19
17					8.78	9.63	8.95	8.87	12.68	12.49	12.82	12.95	15.81	13.78	15.49	15.45	12.42	12.24	12.52	12.62	18
18					9.15	9.47	9.35	9.08	12.72	12.71	13.36	12.39					12.38	12.39	12.94	12.06	20
19											12.05	11.85			15.72	15.29			12.97	12.91	13
20					8.33	7.52	8.18	7.67	13.00	12.42	12.49	13.09					11.18	10.40	10.61	10.87	17
21					9.43	9.21	12.58	10.72									12.13	10.47			13
22					8.29	8.00	7.61	8.33	13.50	11.93	12.75	12.31	15.60	13.87	14.71	15.96	11.14	10.17	10.14	10.52	18
23					9.09	8.93	8.34	8.75	13.19	12.60	13.10	13.59					11.88	11.31	11.34	11.71	20
24					8.58	8.52	8.26	8.71	12.95	12.32	13.40	12.61					11.56	11.05	11.51	11.00	20

TABLE No. 91.—*Average Sucroses*—Continued.

Number of cane.	First set.—Average sucrose below 5 per cent.				Second set.—Average sucrose 5 to 10 per cent.				Third set.—Average sucrose 10 to 15 per cent.				Fourth set.—Average sucrose over 15 per cent.				Final averages.—Average sucrose for each cane.				Number of analyses.
	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	
25					9.03	8.74	8.48	8.35	13.32	13.01	13.13	13.24					12.04	11.51	11.34	11.62	17
26					9.73	9.05	8.89	8.52	12.52	13.24	13.45	12.61	15.73	13.72	15.84	15.10	11.59	11.03	11.18	10.88	16
27			4.94	4.70			8.43	8.76			11.72	12.96			16.10	16.15			10.10	10.28	17
28							8.77	8.88			12.18	13.13			15.64	15.93			11.04	11.54	16
29					7.42	7.97	8.24	8.07	12.51	11.81	13.05	12.17					10.11	9.89	10.49	9.99	16
30							8.80	8.54			11.84	12.54			15.01	16.06			10.63	10.79	15
31	1.46	8.73	3.95	4.38	6.68	6.85	7.83	7.82	9.10	10.98	11.36	11.02					7.09	8.17	8.64	8.56	17
32	3.80	3.87	4.05	4.34	8.46	8.08	8.21	6.66	12.24	11.69	11.59	11.45					9.23	8.33	8.40	7.87	19
33	3.05	3.53	3.59	3.71	6.74	7.39	8.26	8.47	11.60	11.27	11.71	12.18					6.90	7.21	7.55	7.97	21
34	3.56	4.05	3.49	3.68	8.35	7.99	7.51	7.71	11.11	12.48	11.69	11.99					7.49	7.87	7.25	7.51	15
35	3.11	3.39	2.89	3.47	6.89	7.17	8.00	7.82	11.28	11.11	10.90	12.15					7.04	6.70	6.91	7.62	23
36	3.34	3.38	3.29	3.39	7.68	7.72	7.66	7.53	11.79	10.16	12.32	10.87					7.82	7.09	7.49	6.93	19
37	3.10	6.59	2.27	3.71	8.55	7.41	7.71	8.89	10.70	9.98	12.15	12.55					8.44	7.89	8.21	6.93	18
Averages	3.23	3.98	4.02	3.72	8.17	8.12	8.31	7.65	12.38	11.88	12.38	12.43	15.60	14.27	15.48	15.50	10.79	10.55	10.82	10.68	
Order	C.				C.				D.				A.				C.				
	B.				A.				A. C.				D.				A.				
	D.				B.				B.				C.				D.				
	A.				D.								B.				B.				

TABLE No. 92.—*Average Glucoses.*

Row.	First set.—Glucose corresponding with average sucrose below 5 per cent.				Second set.—Glucose corresponding with average sucrose 5 to 10 per cent.				Third set.—Glucose corresponding with average sucrose 10 to 15 per cent.				Fourth set.—Glucose corresponding with average sucrose over 15 per cent.				Final averages.—Average glucose for the row.			
	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.
1					2.19				1.39	1.52	1.40	1.31					1.43	1.52	1.49	1.31
2					1.79	2.58	1.30	1.87	1.54	1.63	1.63	1.38					1.58	1.72	1.62	1.44
3					2.23	1.96	1.83	1.57	1.57	1.67	1.66	1.54					1.66	1.71	1.69	1.55
4					1.65	1.64	2.61	1.80	1.48	1.52	1.43	1.54					1.51	1.54	1.57	1.57
5			.67		3.18	1.50			1.44	1.36	1.44	1.34				.98	1.59	1.37	1.37	1.31
6									1.31	1.56			1.56	.94			1.32	1.51		
7									1.12	1.03			.46				1.08	1.03		
8									1.54	1.21	1.45	1.23					1.54	1.21	1.45	1.23
9					2.45	2.69	3.09	2.89	1.19	1.25	1.18	1.21	.72	.93	1.00	.88	1.48	1.66	1.54	1.55
10					2.15	2.06	2.17	2.30	1.25	1.55	1.24	1.41					1.46	1.68	1.52	1.66
11					2.09	2.59	1.54	2.71	1.27	1.33	1.43	1.49					1.34	1.46	1.44	1.62
12											1.04	1.10			.58	.54			.85	.88
13											1.46	1.38			1.22	1.19			1.44	1.37
14							2.11	1.48			1.13	1.06			.66	.76			1.14	1.04
15					3.72	3.62	3.75	3.71	2.22	2.24	2.41	2.30					2.35	2.37	2.55	2.45
16					3.10	3.09	3.02	3.02	1.36	1.83	1.68	1.41	.60	1.07	.85	.69	1.57	1.99	1.87	1.65
17					4.03	3.65	3.87	3.73	1.86	1.97	1.98	2.04	.98	1.08	1.70	1.40	2.03	2.10	2.20	2.20
18					3.83	3.49	3.86	3.84	2.24	2.23	2.21	2.34					2.38	2.35	2.37	2.49
19											1.37	1.43			.68	.60			1.21	1.15
20					3.88	3.49	3.53	3.77	1.66	2.19	2.44	1.89					2.51	2.77	2.96	2.72
21					1.18	1.53			1.34	1.32							1.31	1.35		
22					2.23	2.17	2.28	2.40	1.27	1.53	1.56	1.74	.95	1.46	1.40	.98	1.67	1.84	1.92	2.05
23					3.37	3.51	3.54	3.70	1.88	2.46	2.10	2.42					2.33	2.78	2.58	2.85

TABLE No. 92.—*Average Glucoses*—Continued.

Row.	First set.—Glucose corresponding with average sucrose below 5 per cent.				Second set.—Glucose corresponding with average sucrose 5 to 10 per cent.				Third set.—Glucose corresponding with average sucrose 10 to 15 per cent.				Fourth set.—Glucose corresponding with average sucrose over 15 per cent.				Final averages.—Average glucose for the row.			
	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.
24	......	......	......	......	3.65	3.71	3.72	3.88	2.05	2.61	2.28	2.58	......	......	......	......	2.54	2.94	2.76	3.02
25	......	......	......	......	3.82	3.85	3.99	3.99	1.79	2.02	1.93	1.98	......	......	......	......	2.40	2.86	2.71	2.69
26	......	......	......	......	3.74	3.70	3.98	4.25	2.55	2.12	2.15	2.22	1.42	1.64	1.02	1.44	2.93	2.80	2.99	3.28
27	......	......	4.61	4.82	......	......	2.76	2.42	......	......	1.96	2.01	......	......	.85	1.95	......	......	2.45	2.41
28	......	......	......	......	......	......	4.15	4.03	......	......	2.47	2.41	......	......	1.27	1.39	......	......	3.06	2.93
29	......	......	......	......	3.91	3.92	3.73	4.26	[illegible]	2.55	2.25	2.34	......	......	......	......	3.14	3.21	3.04	3.36
30	......	......	......	......	......	......	3.98	4.33	......	......	2.45	2.32	......	......	1.90	2.42	......	......	3.13	3.26
31	3.06	2.37	2.61	4.61	2.44	2.36	2.21	2.42	2.16	2.86	1.64	2.09	......	......	......	......	2.40	2.51	2.07	2.46
32	4.43	4.46	4.63	4.42	3.19	3.47	3.64	4.12	1.87	2.69	2.12	2.41	......	......	......	......	2.86	3.43	3.37	3.60
33	4.74	4.93	5.02	5.08	4.15	4.15	3.82	3.56	2.39	2.85	2.61	2.05	......	......	......	......	3.83	4.06	3.88	3.64
34	4.55	4.59	4.74	4.90	3.67	3.72	3.93	3.57	2.97	2.66	2.97	2.67	......	......	......	......	3.73	3.72	3.94	3.77
35	4.73	4.69	4.80	4.82	4.17	3.94	3.90	3.89	2.55	2.88	2.80	2.52	......	......	......	......	3.91	3.99	3.98	3.83
36	4.61	5.12	4.86	4.44	3.77	4.06	3.92	3.94	2.32	3.37	2.28	2.55	......	......	......	......	3.55	4.20	3.82	3.88
37	2.53	1.97	3.09	3.52	2.69	2.87	3.06	3.19	2.51	2.60	2.42	2.41	......	......	......	......	2.64	2.71	2.91	3.08
Averages	4.43	4.50	4.51	4.75	3.22	3.28	3.34	3.40	1.72	1.87	1.81	1.80	.98	1.25	.88	.94	2.25	2.41	2.38	2.37
Order	D. C. B. A.				D. C. B. A.				B. C. D. A.				B. A. D. C.				B. C. D. A.			

TABLE No. 93.—*Average Solids.*

Row.	First set.—Solids corresponding to average sucrose below 5 per cent.				Second set.—Solids corresponding to average sucrose 5 to 10 per cent.				Third set.—Solids corresponding to average sucrose 10 to 15 per cent.				Fourth set.—Solids corresponding to average sucrose above 15 per cent.				Final averages.—Average solids for the row.			
	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.
1					3.48				3.50	3.28	3.30	3.08					3.40	3.28	3.30	3.03
2					3.41	3.44	3.98	4.86	3.44	3.34	3.22	3.46					3.44	3.35	3.28	3.54
3					3.24	2.95	2.36	3.62	3.35	3.04	3.26	3.24					3.33	3.03	3.15	3.28
4					3.55	3.06	2.70	2.51	3.10	3.16	3.03	3.08					3.21	3.15	2.93	3.04
5			3.12		3.19	4.26			2.87	2.92	2.86	3.16				5.23	2.90	3.04	2.89	3.34
6									3.15	3.43			2.54	2.81			3.10	3.38		
7									2.83	3.41			3.75				2.89	3.41		
8									3.23	3.21	3.19	3.31					3.23	3.21	3.19	3.31
9					2.01	2.10	1.83	2.02	3.46	3.14	3.42	4.03	3.16		3.02	2.95	3.00	2.67	3.06	3.39
10					2.07	2.14	2.74	2.38	3.02	3.17	3.18	3.60					2.78	2.89	3.05	3.24
11					2.44	2.53	2.90	2.38	3.22	2.86	3.10	3.08					3.14	2.82	3.16	3.36
12											3.43	3.27			3.90	3.69			3.62	3.43
13											3.22	3.49			3.88				3.27	3.49
14							2.50	2.90			3.06	3.65			3.74	4.59			3.15	3.79
15					2.49	2.82	2.46	2.80	3.02	2.77	3.43	2.96					2.97	2.98	3.32	2.94
16					1.97	2.05	2.46	2.70	2.93	2.96	3.06	3.30	4.28		4.25	4.73	2.89	2.81	3.02	3.21
17					1.44	1.73	1.91	2.02	2.94	3.11	3.01	3.35	4.47	3.63	3.37	4.43	2.85	2.99	2.90	3.32
18					2.29	3.58	2.50	2.25	3.21	3.03	2.85	3.10					3.13	3.09	2.81	3.01
19											3.03	3.01			4.81	5.14			3.35	3.66
20					2.29	2.40	2.57	2.37	3.60	3.34	3.26	3.28					3.13	2.96	2.96	2.90
21					2.61	3.53			2.85	3.31							2.83	3.33		
22					2.58	2.59	2.74	2.36	3.65	3.55	3.16	3.36	4.22		4.66	4.92	3.17	3.04	3.02	2.95
23					2.69	2.55	2.28	2.73	3.51	3.35	3.60	3.54					3.24	3.10	3.11	3.26

TABLE No. 93.—*Average Solids*—Continued.

Row.	First set.—Solids corresponding to average sucrose below 5 per cent.				Second set.—Solids corresponding to average sucrose 5 to 10 per cent.				Third set.—Solids corresponding to average sucrose 10 to 15 per cent.				Fourth set.—Solids corresponding to average sucrose above 15 per cent.				Final averages.—Average solids for the row.			
	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.
24					2.56	2.47	2.32	2.57	3.77	3.49	3.53	3.89					3.37	3.15	3.08	3.41
25					2.69	2.74	2.50	2.80	3.31	3.37	3.20	3.37					3.11	3.15	2.93	3.18
26					2.42	2.06	2.29	2.55	4.12	4.02	3.33	3.93	3.89	3.84	5.07	4.45	3.24	2.97	2.89	3.30
27			1.25	1.42			2.27	2.54			2.69	3.40			4.04	3.97			2.56	2.83
28							2.88	3.13			3.31	3.12			5.10	4.22			3.27	3.19
29					2.35	2.12	2.31	2.17	2.83	2.94	3.21	3.10					2.61	2.52	2.73	2.60
30							2.58	2.44			3.89	3.50			3.40	2.62			3.25	2.86
31	1.11	2.79	2.50	2.04	2.60	2.90	2.59	2.89	2.89	2.96	3.83	3.17					2.58	2.91	2.95	2.92
32	1.76	2.01	1.82	1.90	2.15	1.99	1.76	1.76	3.25	2.75	2.60	2.84					2.51	2.18	2.04	2.15
33	1.78	1.72	1.81	1.83	1.84	2.25	1.98	2.12	2.79	2.85	2.92	3.21					2.08	2.24	2.12	2.26
34	1.39	1.72	1.78	1.49	2.16	2.37	1.89	1.79	2.93	2.96	3.17	3.03					2.11	2.31	2.19	2.02
35	1.57	1.68	1.63	1.37	1.91	2.07	2.14	2.15	3.23	2.92	2.89	2.97					2.15	2.13	2.14	2.25
36	1.59	1.37	1.66	1.49	1.79	1.91	2.10	1.92	2.81	2.96	3.50	3.73					2.01	1.91	2.21	1.94
37	3.37	3.01	2.29	2.73	2.80	2.53	2.33	2.75	2.98	3.77	2.83	4.34					2.89	2.86	2.42	2.93
Averages	1.72	1.81	1.80	1.65	2.39	2.40	2.34	2.46	3.22	3.17	3.20	3.30	3.71	3.43	4.04	4.29	2.93	2.86	2.89	3.00
Order	B. C. A. D.				D. B. A. C.				D. A. C. B.				D. C. A. B.				D. A. C. B.			

EFFECTS OF FERTILIZERS ON THE ASH OF SORGHUM JUICES.

A small number of determinations (34) were made of the ash of various sorghum juices; it was originally intended to make a larger number of estimations for the purpose of showing the effect of these four fertilizers on the amount and composition of the ash in sorghum canes and juices. The pressure of other work and the limited number of assistants prevented the completion of the work, and the results here recorded are given for what they may be worth.

If these results are considered sufficiently numerous to warrant any conclusions, it appears that the amounts of ash are least with fertilizer A, and increase regularly in the order A, B, C, D.

It seems hardly safe, however, to draw any conclusions, and it is intended to present a much larger number of facts bearing upon this point in the next sugar report. We can safely infer, however, that the ash in sorghum juices does not vary greatly from 1 per cent.

The following are the results obtained:

TABLE No. 94.—*Effect of fertilizers on the ash.*

No. of cane.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.	No. of cane.	Fertilizer A.	Fertilizer B.	Fertilizer C.	Fertilizer D.
1	......	......	......	......	22	......	1.46	......	......
2	......	......	......	......	23	......	......	......	......
3	1.13	.95	1.13	1.12	24	......	......	......	......
4	......	......	......	......	25	......	......	......	......
5	......	......	......	......	26	......	.98	......	......
6	......	......	......	......	27	......	......	.85	.95
7	.90	1.66	......	......	28	......	......	......	......
8	......	......	......	......	29	......	......	......	......
9	......	......	......	......	30	......	......	......	......
10	1.13	.93	.97	1.11	31	......	......	......	......
11	......	.91	......	......	32	......	......	......	......
12	......	......	1.52	1.55	33	......	......	......	......
13	......	......	.84	1.00	34	......	......	......	......
14	......	......	1.23	1.11	35	......	......	......	......
15	......	......	......	......	36	......	......	......	......
16	.91	1.03	1.08	1.05	37	......	.88	......	......
17	.82	.88	......	......	10 (Dupl.)	.94	.88	......	......
18	......	.88	......	......		5.83	12.59	8.71	9.01
19	......	......	1.09	1.12	No. estimations	6	12	8	8
20	......	1.15	......	......	Average	.97	1.05	1.09	1.13
21	......	......	......	......					

COMPOSITION OF ASH OF CANES AND JUICES OF SORGHUM.

The actual composition of the pure ash, both of the whole cane and the expressed juice, are matters of interest and importance. From a careful study of the following figures it will be seen that the amount of potash extracted from the soil is much greater than the amount of any other ash ingredient, while the quantity of phosphoric acid is small. It would seem, then, that the farmer should supply these two constituents, when his soil seems to need them, in about the relative proportions in which they exist in the ash. The following are analyses of two lots of ash from sorghum, and two samples of ash from sorghum juices:

Analyses of ash from sorghum canes and juices.

Constituents.	Canes.		Juices.	
	No. 1.	No. 2.	No. 1.	No. 2.
Potash, K_2O	49.66	33.77	*55.31	*54.76
Potassium, K	4.31	14.58	......	......
Sodium, Na	......	......	Trace.	.07
Lime, Ca O	13.49	9.00	7.20	7.40
Magnesia, Mg O	10.47	10.28	6.36	7.85
Iron Oxide, Fe_2O_3	......	......	2.01	1.63
Silica, SiO_2	8.97	2.93	6.31	2.57
Sulphuric acid, SO_3	5.55	11.70	5.11	4.11
Phosphoric acid, P_2O_5	3.64	4.50	8.22	5.72
Chlorine, Cl	3.91	13.24	9.08	15.89
	100.00	100.00	100.00	100.00

*It was thought best in these analyses to state all the potassium as oxide, although, doubtless, a part existed in the juice in combination with chlorine.

TABLE No. 95.—*Statement showing the mean temperature and total rainfall recorded at the station of observation of the Signal Service, U. S. Army, at Washington, D. C., for each day from May 1 to November 30, 1880.*

[Compiled from the records on file at the office of the Chief Signal Officer.]

Day of the month.	May, 1880.		June, 1880.		July, 1880.		August, 1880.		September, 1880.		October, 1880.		November, 1880.	
	Mean temperature.	Total rainfall.	Mean temperature.	Total rainfall.	Mean temperature.	Total rainfall.	Mean temperature.	Total rainfall.	Mean temperature.	Total rainfall.	Mean temperature.	Total rainfall.	Mean temperature.	Total rainfall.
	°	In.	°	In.	°	In.	°	In.	°	In.	°	In.	°	In.
1	52.7	......	71.5	.16	73	.31	79.5	......	74.7	.02	54.7	......	46.2	......
2	64.7	......	57.2	.24	75.5	.04	82.2	—	72.2	......	59	......	50	......
3	67.7	......	66.2	......	72.8	......	75.5	1.01	81.7	......	63.2	......	51.5	—
4	67.2	......	70.2	......	75.5	......	71.7	.97	83	......	68.2	.28	57.5	.62
5	67	......	71.2	......	76.8	.18	67.7	.12	82.5	—	59.5	.48	63.2	.06
6	74.5	......	75.7	......	78	......	70.5	......	78.5	.10	61	......	66.5	.16
7	66.1	......	78.2	......	80	......	74	......	68.5	1.26	51.5	......	44.3	.07
8	71.5	......	73.5	......	80.5	.03	72.2	......	61	.05	54.5	......	45.3	......
9	77.5	......	67	......	88	.03	76.2	......	55.5	1.48	58.7	......	47.3	......
10	78	......	67.7	.06	84.7	......	77.5	.06	60.2	......	62.5	......	56.5	.43
11	73	1.40	79.7	.14	81.2	—	74.7	—	64.2	......	66.7	......	58.3	.15
12	68.5	......	81	.23	82.5	......	74.7	......	67.2	......	63.7	—	52.5	......
13	59.7	......	83.2	—	86.5	......	74.7	......	66	.36	54.2	......	37.3	.01
14	54	......	75.2	.03	83	.01	76.5	.12	58.5	......	54.5	......	37	.01
15	57	......	61.7	2.28	79.2	.02	73	.18	59.7	......	66.7	......	36.5	......
16	66.5	......	63.5	.18	81.2	—	68.7	......	65.7	......	72.5	—	38.7	......
17	76.5	......	71.2	......	78.5	......	71	......	72.5	......	54.2	.23	43	......
18	78.7	......	73	......	77.8	—	70.2	.05	74.2	......	47	......	35	—
19	72	......	74	......	79	......	76.5	.13	74.5	......	44.7	......	29.2	......
20	79.7	......	75.2	......	74.7	.23	79	.01	76.2	......	50	......	38.2	.09
21	76.7	......	78.2	......	72	—	81.5	......	69.7	—	54.7	......	30.7	......
22	66.5	.70	81	......	64.5	1.40	79.5	—	61.7	......	56	.17	20.5	......
23	66.5	.91	81.5	......	71	......	80.2	—	60	—	48	.20	22.5	......
24	75	......	85	......	76.7	......	82	—	63.5	......	43.5	—	27.2	......
25	82.5	......	81.5	.10	76.2	......	79.2	.65	67.7	......	43.5	......	30.7	.04
26	83.5	......	79.7	.10	80.7	......	68.7	.02	68.7	......	54.7	.01	24.7	.17
27	82.2	......	80.5	—	76.5	—	72.7	......	74.2	......	53	.03	29.7	......
28	75	.04	83.5	—	72.6	......	78	......	61.5	.15	40	.23	32.7	.63
29	70.2	—	80.5	—	72	......	79.2	.02	60.2	......	46.5	.03	38.7	......
30	72	.32	76.7	......	72	......	73	.25	53	......	61	.65	33.7	.04
31	74.2	......	......	......	75.7	......	67.7	.11	......	......	50.7	......	......	......

Statement showing the maximum and minimum temperatures from October 1 (date of first frost) to November 30, 1880; frosts since October 1, 1880; as recorded at the station of the Signal Service, U. S. A., in Washington, D. C.

[Compiled from the records on file at the office of the Chief Signal Officer, U. S. A., Washington, D. C.]

TEMPERATURE.

Day of month.	October, 1880.		November, 1880.		Day of month.	October, 1880.		November, 1880.	
	Max.	Min.	Max.	Min.		Max.	Min.	Max.	Min.
1	67	38.5	58	34.5	17	70	46	51	32
2	72	43	63	38	18	57	40	48	26
3	74	47.5	60	37	19	57	30.5	33	19
4	80	57	62	49	20	60	41	34	30
5	64	55	68	58	21	64	42.5	39.5	26
6	76	54.5	70	59	22	59.5	50	28	12.5
7	65	44	69	41	23	55	44	29	12.5
8	67	39	57	33	24	49	40	31	13
9	70	47.5	62	39	25	54	33	36	28
10	76	48	63	39	26	62	38	29	22
11	80	50.5	67	50	27	61	49	36	22
12	80	55	62	47	28	49	39	34	28
13	65	45.5	48	35	29	49	39	45	32.5
14	68	38.5	40	34	30	63	48	37	30
15	80.5	50	42	32	31	58	45	......	......
16	81.5	60	51	28					

Frosts (fall of 1880-'81).—October 1, 19, 25; November 1, 2, 3, 8, 9, 16.

*Heavy rainstorms May 1 to November 30, 1880, inclusive.**

Date.	Began.	Ended.	Amount.
			Inches.
May 11	4.34 p. m	6.05 p. m	1.40
June 14 to 16	8.25 p. m. 14th	8.10 a. m. 16th	2.46
July 22	6.10 a. m	4.10 p. m	1.37
August 3 to 4	4.20 p. m. 3d	8.50 p. m. 4th	1.89
September 6 to 7	8.35 p. m. 6th	5.00 a. m. 7th	1.34
September 8 to 9	6.15 a. m. 8th	10.00 p. m. 9th	1.53

*All rainstorms between the dates named in which the amount of precipitation exceeded one inch are here given.

WAR DEPARTMENT, OFFICE OF CHIEF SIGNAL OFFICER,
Washington, D. C., March 16, 1881.

TEMPERATURE AND RAINFALL FOR THE SEASON.

The above official record of the mean temperature and total daily rainfall has been added in order to show, more exactly than could be done by mere general statements, the conditions under which the canes here examined were grown. The following averages were drawn from these figures:

Month.	Average mean temperature.	Average daily rainfall.
		Inches.
May	70.8	0.11
June	74.8	0.12
July	77.2	0.07
August	75.1	0.12
September	67.9	0.11
October	55.4	0.07
November	40.7	0.08

It will be noticed that there were six days when the rainfall was so much in excess of the daily average as to indicate heavy storms. These days were

	Inches rainfall.
May 11	1.40
June 15	2.28
July 22	1.40
August 3	1.01
September 7	1.26
September 9	1.48

COMPARATIVE VALUE, DURING THE WORKING PERIOD, OF SORGHUM AND CORNSTALKS.

From the following table it is possible to judge quite accurately as to the comparative values of the different canes for the production of sugar. These values are applicable more especially to the latitude of Washington, and it will be seen later that certain canes which do not stand high in the list, when grown in this section, are very likely to prove valuable where the growing season is longer.

Again, those which mature quickest and also have a long working period are the ones especially recommended for culture in more northern latitudes.

In this table the canes are arranged in the order of their comparative value, as shown from the large number of analyses recorded. It must not be inferred, however, that it is possible to state positively that this order may not be somewhat modified by future experience; it certainly would be somewhat changed were any one characteristic of the juice used as the basis of comparison to the exclusion of all others. It has been attempted to give due weight to all the factors which tend to show the good or bad qualities of the canes.

Among the points which have the most direct bearing on the determination as to the value of any cane for any locality are the following:

1st. Other things being equal, that cane is best adapted to any locality which most quickly reaches the working stage, and longest continues workable. It will be noticed that, judged by this rule, the first eight varieties are superior to those that follow. It appears also, that these varieties matured in from 77 to 89 days, and continued workable from 87 to 107 days, or, on an average, over *three months*. It is very important to have sufficient time in which to work up the crop.

2d. The *average purity of the juice* is another very important consideration. This is shown by the column headed "average exponent"; by this term is meant the percentage of pure crystallizable sugar in the total solids of the juice. As has already been stated in the discussion of the table of specific gravities, the exponent should not fall below 70 for the best results.

3d. The *average available sugar in the juice* has very much to do with its value. The figures in this column were calculated by multiplying the figures in the column showing "average per cent. sucrose in juice" by the corresponding figures for "average exponent."

4th. The *pounds of juice per acre* has much to do with the amount of sugar that can be obtained.

As will be seen, the various canes do not differ very materially in the percentage of juice they can furnish; hence, the pounds of juice per acre depends more directly upon the number and weight of canes which can be raised. By reference to the tables for each variety, it will be

seen that several of the varieties standing low in this list (Honduras, Honey Top, &c.) furnish canes much heavier than those standing near the first of the list; hence, if an equal number of such heavy canes could be grown on an acre, the amount of juice must be correspondingly greater.

If, then, the quality of the juice from heavy canes is as good as that from the light, and the season for working is greater, the heavy canes would be preferable, because they would furnish the larger amount of sugar per acre. Unfortunately, this is not the case in this latitude. The first two columns in this table show that the heavier canes do not attain their full growth and maturity in time to be worked up into sugar.

It is fully believed that these heavy canes are well adapted to the more southern parts of the United States, and that in those regions they will reach full maturity in time to leave an ample working period. In fact, several examinations of canes sent from South Carolina a year ago confirm these statements.

If it be supposed, for sake of comparison, that an equal number of canes of each variety can be grown on an acre of land, the results given in the last three columns will show what amounts of stripped stalks, juice, and available sugar can be obtained on an acre from each variety of corn and sorghum. The number of stalks per acre has been placed at 24,000, which is believed to be a fair estimate.

In comparing these figures with those in the three columns just preceding them, which represent actual results of analyses, it will be seen that the figures do not differ greatly.

6th. After all, the real test of value for any cane is the amount of crystallizable sugar that can be actually separated from the juice obtained from the stalks grown on an acre. This amount will depend very greatly on the quantity and quality of the canes, and upon the promptness and care with which they are worked up after cutting. The figures here given in explanation of the various points which have been discussed have been derived from very carefully conducted work, and they are offered as fair statements of what can and should be attained by careful workers.

Among the essential points worthy of repetition are the following:

1st. Select a cane that matures quickly, and has as long a working period as possible.

2d. Do not work the cane too early; the seed should be well matured and quite hard, and the juice should have a specific gravity of 1.066 or higher.

3d. After cutting the canes, work them up without great delay. It is best to draw directly from the field to the mill as may be needed.

TABLE No. 96.—*Table showing the comparative value, during the working period, of all varieties of sorghum and cornstalks here examined.*

	Name.	Source of seed.	Number of days to maturity.	Number of days for working.	Number of analyses.	Average per cent. sucrose in juice.	Average per cent. glucose in juice.	Average per cent. other solids in juice.	Average exponent.	Average per cent. available sugar.	Average per cent. juice.	Actually obtained. Stripped stalks, per acre.	Actually obtained. Juice, per acre.	Actually obtained. Available sugar, per acre.	Computed at 24,000 stalks per acre. Stripped stalks, per acre.	Computed at 24,000 stalks per acre. Juice, per acre.	Computed at 24,000 stalks per acre. Available sugar, per acre.
	VARIETIES OF SORGHUM.											*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	Early Amber	D. Smith	77	99	80	12.42	1.55	2.98	73.15	9.11	60.02	27,073	16,249	1,480	25,520	15,317	1,395
2	Early Amber	Plant Seed Company	80	99	70	12.00	1.51	3.18	71.72	8.67	61.33	29,808	18,281	1,585	24,480	15,023	1,302
3	Early Golden	A. B. Swain	80	104	76	11.47	1.76	3.09	70.24	8.12	60.03	24,611	14,774	1,200	24,480	14,695	1,352
4	Golden Sirup	W. H. Lytle	87	82	67	12.48	1.42	2.99	73.65	9.24	61.36	15,822	9,708	897	24,480	14,023	1,388
5	White Liberian	D. Smith	88	101	39	13.43	1.31	3.17	74.98	10.08	63.82	32,165	20,528	2,069	31,920	20,371	2,053
6	Early Amber	S . Evans	89	96	24	13.21	1.54	3.28	73.23	9.69	59.02	27,962	16,503	1,599	23,760	14,023	1,359
7	Black Top	D. W. Aiken	87	87	35	12.69	1.21	3.07	74.75	9.51	61.35	21,907	13,440	1,278	22,800	13,977	1,329
8	African	W. E. Parks	87	107	83	11.50	1.46	3.14	70.28	8.13	62.92	21,716	13,664	1,111	27,840	17,517	1,424
9	White Mammoth	Amos Carpenter	102	83	32	13.51	1.18	3.45	74.50	10.13	62.31	29,341	18,282	1,851	31,680	19,740	1,999
10	Oomseeana	Blymyer & Co	115	77	54	12.16	1.49	3.07	72.43	8.81	64.15	19,522	12,523	1,103	27,840	17,859	1,573
11	Regular Sorgho	Blymyer & Co	101	93	71	11.80	1.49	3.03	72.27	8.70	60.77	26,611	16,172	1,407	30,720	18,669	1,624
12	Hybrid	E. Link	101	84	30	14.24	.93	3.43	76.08	10.84	63.53	34,477	21,903	2,374	42,240	26,835	2,909
13	Sugar Cane	J. W. Barger	108	77	28	13.82	1.49	3.13	74.18	10.27	62.32	21,117	13,150	1,350	21,600	13,461	1,382
14	Oomseeana	D. W. Aiken	104	88	35	12.84	1.12	3.31	74.21	9.57	62.04	22,825	14,160	1,355	28,080	17,420	1,667
15	Neeazana	W. H. Lytle	136	58	38	13.16	1.93	3.18	72.13	9.48	61.58	23,467	14,451	1,360	26,400	16,257	1,441
16	Goose Neck	P. P. Ramsey	111	72	44	12.26	1.46	2.99	73.29	7.58	62.12	27,362	16,997	1,288	30,480	18,934	1,435
17	Early Orange	——— Hedges	117	79	53	13.18	1.58	3.39	72.45	9.56	61.67	48,758	30,069	2,875	35,520	21,903	2,094
18	Neeazana	Blymyer & Co	129	65	46	13.45	1.95	3.11	72.77	9.78	60.52	20,156	12,198	1,193	25,200	15,241	1,491
19	New Variety	E. Link	108	84	31	12.84	1.19	3.35	73.93	9.50	65.22	30,731	20,042	1,904	28,320	18,470	1,755
20	Chinese	D. Smith	137	57	36	13.18	1.81	3.68	70.66	9.22	60.43	30,956	18,707	1,725	32,720	19,773	1,823
21	Wolf Tail	E. Link	118	56	21	11.72	1.23	2.98	71.87	8.65	62.09	31,493	19,554	1,691	30,960	19,223	1,663
22	Gray Top	H. C. Sealey	135	59	33	13.03	1.47	3.54	72.19	9.42	63.00	29,887	18,809	1,772	28,800	18,144	1,709
23	Liberian	Blymyer & Co	131	38	22	13.18	2.05	3.22	71.23	9.39	62.02	45,580	28,269	2,654	45,120	27,983	2,628
24	Liberian	W. H. Lytle	134	48	36	12.92	2.09	3.37	70.31	9.08	62.56	44,913	28,088	2,550	44,400	27,777	2,522
25	Oomseeana	W. I. Mayes & Co	127	67	36	13.62	1.74	3.40	72.50	9.88	61.89	35,414	21,918	2,165	42,480	26,291	2,588
26	Sumac	W. Pope	152	31	14	14.24	1.67	4.18	70.82	10.09	60.15	39,919	24,011	2,423	39,360	23,675	2,389
27	Mastodon	D. W. Aiken	128	60	23	11.24	1.68	3.03	69.93	7.95	64.27	20,413	13,119	1,043	47,760	30,695	2,440
28	Imphee	D. W. Aiken	155	37	9	14.21	1.76	3.61	72.56	10.31	61.67	37,031	22,837	2,354	37,920	23,385	2,411
29	New Variety	J. W. H. Salle	172	7	5	13.99	2.02	3.73	70.88	9.92	58.57	26,090	15,287	1,516	25,920	15,181	1,506
30	Sumac	J. H. Wighton	168	20	6	14.40	1.80	3.40	73.53	10.58	60.84	39,815	24,223	2,563	36,960	22,486	2,388
31	Honduras*	Arsenal	148	29	27	10.32	2.26	3.09	65.76	6.81	57.09	25,335	14,464	985	29,760	16,990	1,157

32	Honey Cane†	J. H. Clark	133	43	21	10.80	1.56	2.51	67.76	7.37	65.03	50,017	30,301	2,233	53,760	34,987	2,579
33	Sprangle Top*	W. Pope	153	38	20	11.21	2.61	2.94	66.79	7.51	65.91	46,634	30,736	2,308	44,880	29,580	2,221
34	Honduras	E. Link	157	10	4	12.83	1.80	2.95	72.98	10.06	65.06	45,695	29,729	2,991	50,740	33,011	3,321
35	Honey Top, or Texas Cane*	Brussels, Mo	163	20	7	12.98	2.11	3.92	66.27	8.86	64.68	47,246	30,559	2,708	51,220	33,128	2,939
36	Honduras*	L. Brande	164	22	7	11.67	2.03	3.22	69.00	8.06	66.59	46,421	27,912	2,250	51,840	34,510	2,782
37	Sugar Cane*	C. E. Miller	99	8	6	8.84	2.37	2.32	65.39	5.79	64.60	13,839	8,940	518	17,280	11,163	649
38	Hybrid	J. C. Moore	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
	VARIETIES OF CORN.																
39	Rice or Egyptian	Root & Hollingsworth	......	......	4	11.77	.59	3.90	72.32	7.51	42.41	18,497	7,845	589	10,320	4,377	329
40	Doura Corn		......	......	3	12.75	1.97	3.87	68.59	8.75	43.56	39,900	17,380	1,521	22,080	9,618	842
41	Stowell's Evergreen	W. R. Shelmire	......	......	5	10.92	1.05	3.26	71.70	7.83	55.30	8,835	4,886	383	14,640	7,975	624
42	Egyptian Sugar	W. R. Shelmire	......	......	5	10.38	1.55	2.82	70.37	7.30	58.14	14,084	8,188	598	23,280	13,540	983
43	Lindsay's Horse Tooth	A. H. Lindsay	......	......	7	11.55	.94	3.53	72.10	8.33	57.58	24,753	14,253	1,187	41,040	23,631	1,968
44	White Flat Dent, 8-rowed	Washington Market	......	......	6	10.80	.88	2.96	73.77	7.97	59.68	22,256	13,282	1,059	36,720	21,914	1,747
45	Improved Prolific	James M. Thorburn & Co.	......	......	5	10.47	.80	3.72	69.85	7.31	57.51	21,562	12,400	906	35,560	20,451	1,495
46	White Dent	Thomas L. Jones	......	......	6	11.08	1.15	3.04	72.56	8.04	55.99	21,929	12,270	986	36,240	20,291	1,631
45	Sanford Corn	F. B. Hatheway	......	......	5	9.33	1.12	3.51	66.85	6.24	47.63	6,187	2,947	184	10,320	4,915	307
48	Mammoth Dent	M. J. Varney	......	......	7	10.86	.85	3.81	69.96	7.64	53.54	15,642	8,375	640	25,920	13,878	1,060
49	Early Minn. Dent	M. J. Varney	......	......	3	10.92	1.08	4.75	65.20	7.12	36.15	4,278	1,546	110	6,960	2,516	179

* The juices of these five canes did not reach the exponent 70. (see remarks later).
† The juice of this cane in some cases reached an exponent above 70., but did not average it (see remarks later.)

ANALYSES OF SIRUPS AND SUGARS RECEIVED FROM ABROAD.

The analyses which follow were made for the benefit of various persons who have experimented, usually in the small way, on the production of sorghum sugar and sirups. On the whole the results are good, when it is considered that these are, in most cases, first attempts, made under unfavorable circumstances, with improvised apparatus, and frequently without sufficient attention to details.

Some sirups were slightly scorched, and others were impure from lack of proper defecation of the juice. Still other samples were dark colored from use of too much lime.

Notwithstanding these defects, many other sirups were of light color, pleasant, maple-like flavor, and high content of crystallizable sugar, and a goodly number had crystallized nicely.

In several cases these crystals were separated, and samples sent to the makers; and, in every case where it seemed necessary, letters of advice have been sent to the parties who forwarded the samples.

TABLE No. 97.—*Sorghuum Sirups and Sugars received from abroad.*

Sender.	Date.	No. of analysis.	Glucose.	Surcose.	Polarization.	Water.
SORGHUM SIRUPS.			*Per cent.*	*Per cent.*		
William P. Wheeler, Chittenango, N. Y	Sept. 17	2069	7.05	55.05	....	....
H. F. Tobey, Little Hocking, Ohio	Nov. 1	3366	10.00	60.80	....	....
E. Keyser, Thoroughfare, Va	Nov. 1	3362	10.35	60.46	....	....
M. P. Ayres, Jacksonville, Ill	Oct. 4	2731	10.70	61.84	....	....
William P. Wheeler, Chittenango, N. Y	Oct. 26	3260	14.00	67.44	58.3	....
R. Z. Wise, Middlebranch, Ohio	Oct. 26	3256	16.90	75.52	....	....
Do	Oct. 26	3257	16.60	70.48	....	....
William P. Wheeler, Chittenango, N. Y	Nov. 16	3546	13.00	52.82	51.8	....
M. P. Ayres, Jacksonville, Ill	Oct. 4	2732	14.60	56.42	....	....
Rev. George B. Beecher, Hillsborough, Ohio	Oct. 22	3160	14.00	53.20	....	....
William P. Wheeler, Chittenango, N. Y	Oct. 26	3259	16.50	59.38	48.6	....
Do	Oct. 16	3096	17.15	56.48	54.2	....
R. Z. Wise, Middlebranch, Ohio	Oct. 26	3255	22.20	70.48	56.7	....
Rush G. Leaming, Decatur, Nebr	Feb. 28	3601	16.20	50.74	....	....
Do	Feb. 28	3600	16.65	51.54	....	....
Rev. George B. Beecher, Hillsborough, Ohio	Oct. 8	2860	19.10	53.10	....	6.80
R. H. Phelps, Hartford, Conn	....	3590	11.60	31.73	....	....
William P. Wheeler, Chittenango, N. Y	Nov. 1	3365	14.75	58.74	....	....
W. J. Sharpe, Baton Rouge, La	....	3588	18.00	48.20	....	....
William P. Wheeler, Chittenango, N. Y	Sept. 21	2250	20.40	47.12	....	9.07
W. M. Meigs, Tippecanoe County, Ind	Sept. 20	2150	21.50	45.12	....	....
Rev. George B. Beecher, Hillsborough, Ohio	Oct. 20	2380	23.80	51.35	....	....
William P. Wheeler, Chittenango, N. Y	Sept. 27	2590	22.40	47.50	....	....
R. Z. Wise, Middlebranch, Ohio	Oct. 26	3258	32.00	56.04	45.4	....
T. S. Gold, West Cornwall, Conn	....	3587	22.30	38.00	....	....
Rev. George B. Beecher, Hillsborough, Ohio	Oct. 20	3138	21.07	34.45	....	....
E. Keyser, Thoroughfare, Va	Nov. 1	3363	16.85	38.14	....	....
W. M. Meigs, Tippecanoe County, Ind	Sept. 20	2151	28.50	41.80	....	....
E. Keyser, Thoroughfare, Va	Nov. 1	3364	28.35	37.66	....	....
A. G. Richmond, Canajoharie, N. Y	Oct. 2	2730	29.00	36.86	....	....
Drummond Bros., Warrensburg, Mo*	Dec. 8	3596	29.00	35.40	....	....
A. G. Richmond, Canajoharie, N. Y	Sept. 3	1640	29.09	35.87	....	....
Rev. George B. Beecher, Hillsborough, Ohio	Oct. 22	3161	24.61	27.27	....	....
A. G. Richmond, Canajoharie, N. Y	Sept. 27	2591	35.40	33.80	....	....
Drummond Bros., Warrensburg, Mo*	Dec. 8	3598	35.00	32.10	....	....
A. G. Richmond, Canajoharie, N. Y	Sept. 22	2300	36.80	33.44	....	....
Drummond Bros., Warrensburg, Mo*	Dec. 8	3597	50.35	13.50	....	....
Hon. W. S. Steele, Rockingham, N. C	Dec. 31	3582	....	....	46.0	....
Hon. D. W. Aiken, Cokesbury, S. C	....	3593	....	....	34.5	....
Do	....	3594	....	....	30.9	....
W. R. Andrews, Willimantic, Conn	Jan. 6	3586	....	....	23.6	....
Hon. D. W. Aiken, Cokesbury, S. C	....	3595	....	....	21.2	....
Do	....	3592	....	....	16.2	....
K. E. Randell, Prospect, Ohio						
SORGHUM SUGARS.	Dec. 31	3583	....	....	12.0	....
William Hall, Centreville, Mich	Sept. 9	1899	.90	85.88	....	....
——— ———, New Ulm, Minn	Sept. 9	1900	2.50	87.40	....	....
Drummond Bros., Warrensburg, Mo†	Dec. 8	3599	10.80	59.40	....	....
Captain Blakesley, Saint Paul, Minn	....	3585	....	....	96.00	....

* These sirups were made without defecation of the juice, and contained considerable gum and other impurities.

† This sugar was quite gummy.

UTILIZATION OF WASTE PRODUCTS.

The utilization of the by-products will tend to cheapen the production of sugar, hence it has seemed best to point out some uses of the substances which are most likely to prove of value.

The *molasses*, even after two crops of sugar have been separated, is usually sufficiently sweet and palatable to command a ready sale at profitable prices; if, however, too much lime has been added in defecation, or too high a heat has been employed in evaporation, the molasses will have a dark color; it is still valuable for the manufacture of alcohol or vinegar, through fermentation, induced by ordinary yeast. Both alcohol and good vinegar have been made at this department, by simply diluting the molasses, adding yeast, and setting in a warm room. The alcohol can be readily separated by distillation at low heat; the vinegar is produced in the same manner as cider vinegar.

The *bagasse* is a valuable fodder, being sweeter than ordinary grasses and sufficiently nutritious. A good article of *paper pulp* has been made from this bagasse by the usual methods employed by paper makers.

A determination of the proximate constituents of the dried leaves, stalks, and bagasse is given below, from which it will appear that there still remains a large amount of sugar in the bagasse which the process employed failed to remove from the cane or stalks, also that the per cent. of starch compounds is greater in the pressed than in the unpressed stalks, and that the percentage of nitrogenous matter remains nearly the same. Since the nutritive value of the pressed stalks is nearly if not quite equal to that of the unpressed stalks, weight for weight, and as they are left in a mechanical condition suitable for their preservation as green fodder by the system of ensilage, it would appear desirable that experiments be made leading to their utilization for this purpose.

Proximate analyses of stalks, bagasse, and leaves of sweet corn and sorghum, calculated to the dry substance.

	Unpressed stalks, Early Amber sorghum.	Unpressed stalks, Honduras sorghum.	Unpressed stalks, Egyptian sugar-corn.	Bagasse of Early Amber sorghum.	Bagasse of Honduras sorghum.	Bagasse of Egyptian sugar-corn.	Leaves of Early Amber sorghum.	Leaves of Honduras sorghum.	Leaves of Egyptian sugar-corn.
Organic acid, chlorophyll, color.	7.36	5.39	2.85	1.47	2.01	1.11	1.46	3.29	1.48
Wax	.94	.33	.44	.35	.84	.40	5.05	1.67	.54
Brown resin	6.98	6.00	8.11	5.11	3.53	5.75	7.91	6.67	5.20
Sugars	34.73	38.14	26.01	19.36	21.77	10.08	8.58	9.37	8.21
Gum	2.14	1.57	1.38	2.04	2.20	1.33	3.82	2.78	4.54
Starch isomers	20.34	17.67	22.44	31.46	26.27	23.16	14.49	21.22	24.77
Albuminoids	4.95	4.81	6.90	3.96	3.87	6.04	13.14	10.43	11.34
Alkali extract, by difference.	....	5.15	6.09	13.35	15.10	22.26	12.08	11.98	12.65
Crude fiber	16.01	16.48	19.82	19.10	20.66	25.00	17.98	18.51	20.83
Ash, by ignition	6.55	4.46	5.96	8.80	3.75	4.87	15.49	14.08	10.44
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The *leaves* which are removed in stripping the stalks make an excellent green fodder, much relished by stock.

The *seeds* furnish good food for farm animals. Proximate analyses have been made of the seed of two varieties of sorghum, the Early Amber and the Chinese, the results of which are given below. It will be seen that this seed differs but little in composition from the other cereals, and

closely resembles corn, and it will doubtless prove valuable as food for farm stock.

Seeds deprived of hulls.	Sorghum seeds.	
	Early Amber.	Chinese.
Moisture	10. 57	9. 93
Ash	1. 81	1. 47
Fat	4. 60	3. 95
Sugars	1. 91	2. 70
Albumen, insoluble in alcohol	2. 64	2. 64
Albumen, soluble in alcohol	7. 34	6. 90
Gum	1. 10	. 72
Starch, color, &c	68. 55	70. 17
Crude fiber	1. 48	1. 52
	100. 00	100. 00

It has been reported that sorghum seeds contain considerable tannin, which makes them less valuable as food. We believe that it will be found that the tannin is not present in the seeds themselves (certainly not in the seeds of many varieties), but in the hulls which inclose these seeds. These hulls are very readily separated from some varieties of sorghum seeds (as the White Mammoth, &c.), and with more difficulty from others. This question will be investigated later.

The *skimmings and lime precipitates* from the defecated juices will doubtless be valuable sources of nitrogen for fertilizing purposes, as they contain considerable amounts of nitrogenous substances in mixture with caustic lime and organic salts of lime.

Proximate analyses have also been made of the scum and sediment obtained in defecating the juice, with a view of throwing light upon the chemical character of this important process.

The results of these analyses are given below.

	Liberian lime precipitate.	Honduras lime precipitate.	Honduras skimmings
Moisture	9. 77	7. 69	5. 72
Ash	21. 69	7. 00	14. 30
Chlorophyll and wax	17. 60	8. 95	14. 44
Sugars and amides	10. 80	43. 96	15. 06
Resins and trace albumen	3. 61	3. 26	5. 08
Gum	6. 02	11. 40	11. 10
Albuminoids	22. 58	4. 55	8. 05
Humus-like substances, diff	5. 73	12. 71	5. 58
Crude fiber	2. 20	. 48	5. 49
Starch isomers	Trace.	Trace.	15. 18
	100. 00	100. 00	100. 00

The large amount of ash in Liberian lime precipitate and Honduras skimmings is due to the presence of considerable clay, which had been used to hasten the clarification of the juice. There was little or no clay present in Honduras lime precipitate. The claying seems mechanically to have carried down a large proportion of the albumen in the Liberian lime precipitate.

The very great difference in these waste products is probably due almost wholly to differences in the manipulation of the juices.

The *skimmings*, obtained later in the clarification of the sirup, consist largely of sugar, together with some nitrogenous substances. When diluted with water, treated with yeast, and fermented in a warm place, they have actually furnished very excellent alcohol and vinegar.

It should always be remembered that with this crop, as well as with all others, it is wise for the farmer to return as much as possible to the soil

in the form of manure. If, then, he can utilize these waste products in the feeding of stock and the production of stable manure and compost, the land will be much less rapidly exhausted. In case it is not practicable to feed the bagasse, it furnishes, when dried, an excellent fuel for use in evaporation of the sorghum juices. The ashes thus produced should be carefully protected, under cover, from the action of rain, and should be again returned to the soil.

While it is true that sugar is formed from atmospheric substances (*i.e.*, the water and carbonic acid in the atmosphere and soil), it is equally true that the sorghum plant cannot develop unless the soil can furnish proper amounts of ash ingredients and nitrogenous substances. Hence too great attention cannot be given to the proper maintenance of fertility in the soil. Certainly many soils may produce a considerable number of good crops without any additions of fertilizing materials, but the ultimate exhaustion of such soils by failure to replace the mineral matters removed by crops is certain, and only a matter of time. We have in this country thousands of acres of land, originally good, which have been rendered almost sterile by this slipshod kind of farming, and it is time that more attention was given to this simple truth that *the soil must furnish proper food to the plant, just as the farmer must furnish proper food to his animals.* The failure to furnish suitable plant food in proper amount will result either in entire or partial failure of the crop.

CONCLUSION.

In conclusion we would say that the results this year, obtained from the very large number of analyses that have been made, fully confirm and greatly strengthen the belief that the economical production of sugar from the juice of sorghum is both possible and exceedingly probable. We recognize the fact that this new industry has very much of conservatism to contend with, and that there are inherent difficulties to be overcome, but we also know that this statement is equally true for all other great manufacturing operations. History shows that the establishment of the beet-sugar industry in France and Germany was the outcome of not one year, but twenty years, of careful scientific work. Many experiments proved failures, and many men were found who said from the first that the manufacture of sugar from beets was a commercial impossibility.

But in spite of adverse criticisms, partial failures, and the opposition of many interested parties, the beet-sugar industry did succeed, and to-day two fifths of the sugar consumed by the civilized world is manufactured, at a profit, from sugar beets.

We believe that the chances for the success of sugar production from sorghum are better than were the prospects of the beet-sugar industry.

It must not be supposed, however, that all the practical questions arising in this connection have been, or even soon can be, solved. The development of a great industry is sure to bring to light many important questions bearing on the cheapening and simplification of manufacturing processes, and money is well spent for the honest and painstaking study of such questions.

We believe it to be a wise and enlightened policy for this government to encourage the thorough scientific investigation of these great economic questions, which have so much to do with the financial prosperity of the country.

ANALYSIS OF CORN SMUT.

(*Ustilago Maidis.*)

For the past two years corn smut has been used as a substitute for ergot, and varying reports have been received as to its therapeutic value.

It has long been known that cattle frequently die from eating corn-stalks upon which this smut has been known to exist. With a view of determining the constituents of this substance, and its probable medical virtues, the following analysis has been made.

PROXIMATE ANALYSIS OF CORN SMUT.

Moisture; volatile at 108–112° C		8.88
Sand		4.01
ASH.		
Soluble in water.		
Chlorine, Cl	.20	
Sulphuric acid, SO_3	.27	
Phosphoric acid, P_2O_5	.71	
Alkalies, partly carbonates	2.68	
		3.86
Insoluble in water. Soluble in HCl.		
Lime, CaO	.07	
Magnesia, MgO	.53	
Iron oxide, Fe_2O_3	.35	
Phosphoric acid, P_2O_5	.25	
		1.20
Insoluble in water and acid.		
Silica, SiO_2		.41
ETHER EXTRACT.		
Fixed oil		4.20
Volatile amine body		Traces
EIGHTY PER CENT. ALCOHOL EXTRACT.		
Soluble in water.		
Precipitated by ammoniacal lead acetate.		
Organic acid, as malic	.67	
Yellow color	.51	
Not precipitated by ammoniacal lead acetate.		
Glucose	1.60	
Reddish extractive	4.32	
Insoluble in water.		
Albuminoid matter	.70	
Resin and red-brown color	2.04	
		9.84
AQUEOUS EXTRACT.		
Albuminoid, coagulated by heat	.70	
Gum	.34	
Sclerotic acid*	5.51	
		6.55
Color (yellow), organic acid and extractive		Traces
ACID EXTRACT.		
Starch isomers, by titration		12.87
ALKALI AND HYPOCHLORITE EXTRACTS.		
Albuminoids	12.95	
Other dissolved substances †	32.67	
		45.62
UNDISSOLVED RESIDUE.		
Pure cellulose		2.56
		100.00

* This term is used provisionally; as here determined, this substance was prepared exactly as recommended by Dragendorff for analysis of ergot, and it certainly contained nitrogen. The residue became dark brown on drying.

† It is very probable that among these dissolved substances is included a very large proportion, if not all, of the real organic skeleton (corresponding to true *cellulose* of

PERCENTAGE COMPOSITION OF PURE ASH.

Soluble in water.		
Chlorine, Cl	3.66	
Sulphuric acid, SO_3	4.94	
Phosphoric acid, P_2O_5	12.98	
Alkalies, partly carbonates	48.99	
		70.57
Insoluble in water. Soluble in HCl.		
Lime, CaO	1.28	
Magnesia, MgO	9.69	
Iron oxide, Fe_2O_3	4.57	
Phosphoric acid, P_2O_5	6.40	
		21.94
Insoluble in water and acid.		
Silica, SiO_2		7.49
		100.00

Of the constituents which have been separated, the following seem to be the most interesting and the most likely to have medicinal activity:

Firstly. The fixed oil. This oil is of an orange-yellow color, peculiar odor, acrid taste, freely soluble in ether, moderately in alcohol, and is, apparently, a glycerine ether. It appears very similar to the oil of ergot, but is found in corn smut in much smaller amount than in ergot, for, while ergot contains 30 per cent., corn smut contains only about 4.2 per cent.

Secondly. Ether also extracts a volatile substance having a peculiar musty or fish-like odor, and a decided alkaline reaction. The amount extracted from one gram of the sample is equivalent to 0.1 cm^3 of $\frac{1}{5}$ normal acid.

It will be seen that the amount is very small. Upon distilling 50 grams of corn smut with water in presence of 5 grams of barium hydrate, a strongly-smelling alkaline distillate was obtained, which neutralized 4 cm^3 (approximately) of $\frac{1}{5}$ normal acid.

Upon adding a slight excess of hydrochloric acid and evaporating the aqueous distillate to dryness, a small nearly white residue was obtained. When this was treated with absolute alcohol, a small portion remained undissolved. The filtrate upon evaporation weighed .0256 gram.

The amount being very small, it was impossible to identify this substance with certainty.

The aqueous solution, when treated with platinic chloride and considerably concentrated, gave feathery crystals totally unlike the octahedral crystals formed by ammonium chloride; hence ammonia was not present.

Another portion of this aqueous solution of hydrochlorate, when treated with the usual alkaloid reagents, gave no precipitates; hence the substance was neither an alkaloid nor was it trimethylamine.

Thirdly. Eighty per cent. alcohol extracts 9.84 per cent. of organic matter. The solution, when evaporated and treated with water, is about three-fourths dissolved by cold water, to form an orange-yellow solution which has an acid reaction, and, when evaporated, a peculiar bland taste. It possesses no very characteristic properties. It contains no tannin, and, in fact, seems to be rather indifferent in its chemical properties.

The organic acid forms a soluble barium salt, which yields barium sulphate equivalent to .67 per cent. of malic acid.

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ordinary plant organs) of the spores. Simple extraction with dilute alkali even thrice repeated failed to remove all soluble matters, and the undissolved residue was as black as the original sample.

Labarraque's solution, acting cold, dissolved a considerable amount not removed by alkali, and the remaining well bleached residue had the properties of ordinary cellulose. It is quite likely that it was partly derived from extraneous woody matters in the sample.

The portion insoluble in water consists of an albuminoid substance, a light-yellow resin and a red-brown color. The two latter are soluble in ammonia, and the resin is precipitated by a slight excess of hydrochloric acid.

If this alcohol extract be treated with water and allowed to stand for several days, it decomposes.

Fourthly. After the use of ether and alcohol, cold water extracts 6.55 per cent.

The solution has a light-yellow color, a faint acid reaction, and, upon evaporation, leaves a red-brown hygroscopic residue.

During evaporation a small amount of albuminous matter separates. If this concentrated solution be treated with an equal volume of 90 per cent. alcohol, this albuminous matter separates, together with a small amount of gum. If this precipitate is separated by filtration, and the filtrate again concentrated to a small bulk and treated with a large amount of 90 per cent. alcohol, a flocculent yellowish-white precipitate is produced, which amounts to 5.5 per cent. of the corn smut taken. If this precipitate be removed by filtration and the filtrate concentrated, there will be found a slight residue, of yellow color and acid reaction.

The amount of acid is too small for estimation, but it appears to be oxalic acid. The large precipitate caused by excess of alcohol resembles sclerotic acid found by Dragendorff in ergot.

When dried it is red-brown in color. It is tasteless or nearly so, and contains nitrogen, and when ignited leaves a considerable ash. It is intended to investigate this further.

Fifthly. After treatment with ether, alcohol, and water, the insoluble residue was boiled for several hours with about 300 cm^3 of water to which had been added 5 cm^3 of concentrated sulphuric acid.

The acid liquid thus formed had a yellow color and reduced Fehling's solution in proportion equivalent to 12.87 per cent. of starch. Corn smut contains no true organized starch, hence it is believed that these starch isomers may prove to be a portion of the easily decomposable cellulose of the corn smut itself.

Sixthly. The residue still undissolved by the acid had a black color, and was considerable in amount, apparently equaling more than half the weight of the corn smut originally used. It was treated with a solution containing 5 grams of sodium hydrate in 300 cm^3 of water. A heat below 100° C. was applied for six hours, and then the dark, black liquid was filtered and left a black residue. This residue was well washed with water and treated for two days with 300 cm^3 of Labarraque's solution of sodium hypochlorite. By this means the black residue was perfectly bleached and very greatly diminished in amount. The dark liquid obtained by the use of sodium hydrate, when treated with excess of hydrochloric acid, gave a dark-brown precipitate, which was not further examined.

It is believed that the portion of the corn smut which corresponds to the true fiber of an ordinary plant was dissolved entirely or in greater part by the solutions of acid of soda, and of sodium hypochlorite which were used, and that the residue of cellulose which remained was largely derived from the extraneous woody matters present in the original sample of corn smut.

The substances which seem most likely to have medicinal effect are the fixed oil, the amine-like volatile substance extracted by ether, and the so-called sclerotic acid extracted by water after the use of alcohol. The investigation of these questions would be of considerable interest, and it is hoped that reliable data will soon be furnished.

EXAMINATION OF THE ROOT OF BERBERIS AQUIFOLIUM, VARIETY REPENS. "OREGON GRAPE ROOT."

This plant is found in the mountainous regions of Oregon, California, Utah, Colorado, Nevada, and Montana, from which latter section the sample here examined was received.

The roots as received were in broken pieces about a foot in length and one-fourth inch in diameter; they had a brownish exterior layer, underneath which was a bright yellow layer. The powdered sample has a bright lemon yellow color and a decided bitter taste.

The root is said to be much used in form of decoction for the treatment of what is known as the "mountain fever" among the western miners. By them it is reported to be an efficient tonic and anti-periodic, capable of replacing salts of quinia in the treatment of malarial disorders.

In 1837 a French physician, Piorry,* stated that he preferred a properly made extract of the root of *Berberis vulgaris* (a closely related plant) to quinia salts in all diseases where "he found the spleen enlarged in a patient suffering from ague, intermittent or hectic." Some years later his former pupil, Dr. L. M. Klein, made further experiments in treatment of fevers in Algeria, and he strongly confirmed the statements of Piorry. As the root of *Berberis vulgaris* (the common "barberry" of the Eastern States) is very similar in composition to the root of *Berberis aquifolium*, variety *repens*, the therapeutic action of the two is likely to be about the same, and the statements based on trials of the one are probably applicable to the other. Be this as it may, the fact remains that recent trials in this country seem to show that the tonic properties of *Berberis aquifolium* are unquestionable,† and eclectic practitioners have long claimed that its anti-periodic virtues were equally well defined and established.

A careful chemical analysis of the powdered roots reveals the presence of two alkaloids, to which, in all probability, can be ascribed the medicinal effects of the roots. None of the other substances were of a character likely to have any decided activity.

The first alkaloid, *berberina*, is the substance to which the yellow color of the root is due; it is freely soluble in alcohol, moderately soluble in water and in chloroform and ether. Its taste is decidedly bitter. It forms sparingly soluble lemon or orange yellow salts with sulphuric, hydrochloric, and nitric acids, and salts more freely soluble with acetic, phosphoric, and hypophosphorous acids.

This alkaloid is removed from the plant by water, much more readily if a little acetic acid is added.

The alkaloid and its salts have been used as a tonic, and as an anti-periodic, and glycerine solutions of the alkaloid are still considerably employed in treatment of ulcerated surfaces.

The second alkaloid is called "*Oxyacanthina*;" it is a white, bitter, difficultly crystallizable solid, which changes to a light yellow color if it is long exposed to the air in a moist condition. The presence of a little caustic or carbonated alkali seems to intensify this color, and may possibly cause the change. If this alkaloid be treated with dilute nitric acid in excess, and slightly warmed, it gives off nitrous vapors and is converted partly into a yellowish-red resin-like substance, and a soluble substance much resembling *berberina* in color, and precipitated by Mayer's solution. It

*Lancet, October 5, 1872, p. 498.

†A considerable amount of literature on this subject may be found in the Therapeutic Gazette, Vols. I and II, Detroit, Mich.

may be possible that this alkaloid is closely related to *Berberina*; a similar action occurs with *hydrastina.*

There seem to be no statements regarding the medicinal properties of *oxyacanthina*. As it is easily prepared the matter might readily be investigated. It may be separated from the mother liquors, after *berberina* has been crystallized from extracts of *Berberis aquifolium* or *B. vulgare*, by adding a very slight excess of sodium carbonate solution with constant stirring. The yellowish precipitate should be allowed to separate; it can then be washed on the filter until nearly free from *berberina*, dissolved in dilute hydrochloric acid, and again precipitated by careful addition of ammonia. After washing and drying the substance is moderately pure. It may be further purified by crystallization from alcohol. It cannot be crystallized from chloroform alone.

The other chemical properties of these two alkaloids will be given later in this article.

The yellow alkaloid *berberina* is geographically very widely distributed, plants containing it having been found growing in Europe, Asia, Africa, and America. It is also found, probably in more natural orders, and also in more distinct plants than any other alkaloid—possibly caffeina may prove an exception.

Of the natural orders, it has been found in *Ranunculaceæ*, *Anonaceæ*, *Menispermaceæ*, *Berberidaceæ*, *Rutaceæ*, and *Leguminosæ*. The first five of the above natural orders are closely related, and it may prove that the presence of *berberina*, together with certain other alkaloids, may be of service in the identification and classification of doubtful botanical specimens. Thus it is at present possible to distinguish chemically between the root of *Hydrastis Canadensis* (nat. ord. *Ranunculaceæ*), and the root of *Berberis aquifolium* or *B. vulgaris* (nat. ord. *Berberidaceæ*), for while both plants contain *berberina*, still this yellow alkaloid is associated in *Hydrastis* with a white alkaloid (*hydrastina*), which gives quite different chemical reactions from the white alkaloid of Berberis (*oxyacanthina*). A more complete study of this question would be of scientific and practical interest.

The following is a proximate analysis of the roots:

Proximate analysis of the roots of Berberis aquifolium, variety repens. "Oregon Grape Root."

Moisture		6.08
Ash, soluble in water	1.63	
Ash, insoluble in water	2.08	
		3.71
Crude fiber		23.33
Albuminoids, insoluble in water and alcohol	3.15	
Albuminoids, soluble in alcohol, insoluble in water	1.68	
		4.83
Berberina*		2.35
Oxyacanthina*		2.82
Black substance with oxyacanthina		.23
Resin, insoluble in ether, soluble in alcohol		1.91
Sugars (traces), organic acids (?), extractives, colors		4.55
Ether extract, chiefly wax		1.36
Gum and yellowish color		5.56
Starch isomers, by titration		18.05
Substances extracted by acid and alkali †		25.22
		100.00

* These figures are probably a little too low, owing to the sparing solubility of the alkaloids or compounds which were weighed. The error probably does not exceed 0.1 per cent. in either case, and is probably least for *berberina*, which was weighed as platinum salt. The *oxyacanthina* was weighed as base.

† Determined by difference.

In the following table are given some of the properties and characteristic reactions of these three alkaloids. It will be seen that the different solubilities of the platinum salts (18) and of the tannate (20), and the strikingly different color reactions, especially with sulphuric and molybdic acids (Froehde's reagent) (22), serve to make the distinction between *hydrastina* and *oxyacanthina* comparatively easy and certain.

Lack of material and of time prevented further chemical investigation of *oxyacanthina*.

Comparison of Berberina, Hydrastina, and Oxyacanthina.

	Properties and reactions.	Berberina.	Hydrastina.	Oxyacanthina.
		$C_{20}H_{17}NO_4$.	$C_{22}H_{23}NO_6$(?).	$C_{16}H_{23}NO_6$(?). $C_{32}H_{46}N_2O_{11}$(?).
1	Color	Lemon or orange	Pure white	White; yellowish on exposure.
2	Taste	Bitter	Nearly tasteless	Bitter.
3	Water	Moderately soluble	Insoluble	Nearly insoluble.
4	Absolute alcohol	......do	Soluble	Soluble.
5	Com'l 90 per cent. alcohol.	Soluble.	......do	30 cold; 1 boiling.
6	Ether	Nearly insoluble	......do	125 cold; 4 boiling.
7	Chloroform	Moderately soluble	......do	Freely soluble.
8	Benzole	Nearly insoluble	......do	Soluble.
9	Ammonia	Soluble	Insoluble	Sparingly soluble.
10	Soda	......do	......do	Moderately soluble.
11	Sodium carbonate	......do	......do	Nearly insoluble.
12	Tinct. iodine	Dark red precipitate	Dark red precipitate	Dark brown-red precipitate.
13	Iodine in iodide	Nearly black precipitate.	Nearly black precipitate.	Do.
14	Potas. merc. iodide	Yellow precipitate	Yellow precipitate	Yellowish precipitate.
15	Phosphomolybdic acid	Yellow precipitate; soluble in ammonia.	Brownish precipitate, not soluble in ammonia.	Brownish precipitate, insoluble in NH_4OH, but turned dark-blue by NH_4OH.
16	Potas. cadmium iodide	Yellow precipitate	White precipitate	White precipiate.
17	Picric acid	Yellow precipitate insoluble in dil. HCl.	Yellow precipitate, insoluble in acetic acid.	Yellow precipitate, insoluble in acetic acid.
18	Platinum chloride	Yellow precipitate soluble in HCl.	Yellowish precipitate, soluble in HCl.	Yellowish precipitate, insoluble in HCl.
19	Gold chloride	Yellow precipitate, insoluble in HCl.	Yellow precipitate, insoluble in HCl.	Orange precipitate, insoluble in HCl.
20	Tannic acid	Yellow precipitate, insoluble in HCl or $HC_2H_3O_2$.	Brownish precipitate, soluble in $HC_2H_3O_2$ but insoluble in HCl.	Brownish precipitate, insoluble in $HC_2H_3O_2$ and dil. HCl.
21	Conc. sulphuric acid	Yellowish-red, olive-green, brown, olive-brown.	Yellow, purple-brown, green.	Brownish-purple, browner, more purple on standing.
22	Sulphuric and molybdic acids.	Yellow-brown, olive-green; same warmed.	Deep green, brick-red, red-brown, dark chocolate brown.	Purple; fades slowly; becomes yellow, then green.
23	Conc. nitric acid	Orange-red; no effervescence.	Orange-red; effervesces; brown and darker.	Orange-red; effervesces; color permanent.
24	Fused zinc chloride	Yellow; light brown	Light yellowish-brown.	Chocolate-brown.
25	Specific rotatory power	....	+153.5 (in excess dil. HCl.)	

EXAMINATION OF "NATIVE QUININE."

The sample was received from Western Pennsylvania, where it is said to be used as a substitute for quinia salts. It is said to be taken from pine trees, on which it forms an excrescence. It was a white, soft, almost structureless wood, with fragments of scaly brown bark, resembling that of pine. It was almost impossible to powder the sample, as it was very spongy and gummy. Taste, at first, gummy, sweetish, then, after a time, quite bitter. Treated with hot water, the mass swells considerably and forms a "mushy," thick mixture; if an equal volume of alcohol be added a considerable gum is precipitated, together with the

small amount of fiber present. If the liquid be now filtered, and the filtrate evaporated to dryness, a red-brown resin, insoluble in water and quite soft and waxy, will be found, together with a yellowish, bitter glucoside, which gives reactions like those of the "*Coniferin*," found in pine sap. An alcoholic percolate from this "native quinine" has a decided odor like vanilla. This seems to be due to the presence of "*Vanillin*" in small amounts. Vanillin is now artifically made by the oxidation of the coniferin contained in the sap of pine trees. In this case the oxidation seems to have been effected in the decomposing wood itself. The sample is a good example of what is termed by botanists "a product of retrograde metamorphosis." In other words, it seems to be the result of a diseased condition, whereby the woody fiber of the pine has been almost entirely changed to gum, the coniferin partially oxidized to vanillin, and possibly the resin produced in unusual amount from the turpentine-like substances in the wood. The following determinations have been made:

Resin	68.15
Albuminoids	3.59
Impure coniferin	6.09
Gum, fiber, moisture, ash, by difference	22.17
	100.00

There seem to be no statements regarding the therapeutic value of coniferin, or of this "native quinine." The testimony of competent physicians can only settle this question.

ESTIMATION OF TANNIN.

Of the several methods tested in this laboratory for the quantitative estimation of tannin, in the different tanning materials found in the market, the volumetric one proposed by Estcourt and modified by Löwenthal* has thus far given most satisfaction. This method depends upon the oxidation of a tannin solution by an acid permanganate solution, a definite amount of indigo being added to serve as an indicator in the titration. In order to obtain, as nearly as possible, the reducing coefficient of the tannin of sumach leaves about 100 grams of the latter, after being powdered, were treated as follows, with a view of procuring a sample of nearly pure tannin: An extract was made with hot water, which, after being evaporated to a small bulk, was added to enough alcohol to make the mixture about 80 per cent. alcohol; after filtering, this alcohol was in turn removed by evaporation, and the diluted, filtered solution treated with normal cupric acetate, which gave a soft brown precipitate of a compound of tannin and copper. This precipitate, after being separated and washed several times with water, was suspended in water and decomposed with sulphureted hydrogen. The resulting cupric sulphide was filtered from the solution, the filtrate slightly acidified with sulphuric acid, and, after being neutralized by means of barium hydrate and filtered, was evaporated nearly to dryness, dissolved in 90 per cent. alcohol, and then treated with sufficient ether to form about a 16 per cent. ether mixture; a dark-colored precipitate of small amount was filtered off, and the solution evaporated upon glass plates. The dried residue was scraped from the glass in scales of a rather dark-yellow color. This sample yielded 0.01 per cent. of ash, 0.83 per cent. of organic impurity, 7.25 per cent. water at 100° C. After making deductions for these amounts, 1 gram of pure tannin required for oxidation

* A. H. Allen's Commercial Chemical Analysis, vol. i, p. 292.

0.6239 gram of potassium permanganate, 1 gram of the latter requiring 1.6028 grams of tannin.

A sample of gallotannic acid, obtained in the market, was also tested in the same way, and, after making similar deductions for impurities, 1 gram of the tannin required for oxidation 0.7153 gram of potassium permanganate, 1 gram of the latter requiring 1.3981 grams of tannin. In carrying out these titrations, a water solution containing 0.5 gram of tannin in 1,000 grams was used, 25 grams of the solution being taken for each titration, to which were added 20 c. c. of a solution of potassium sulphindylate, containing about 7 grams of the salt per liter, about 1 liter of water and a few drops of sulphuric acid. This was titrated with a one-fortieth normal solution of potassium permanganate, this concentration giving much more constant results than stronger ones.

In the above formula the indigo solution requires for oxidation about one-third of the entire volume of potassium permanganate used. This relation has been found to work as well as one in which the indigo present would require two-thirds of the volume of potassium permanganate used; the latter being given by some writers as the lowest ratio in which the indigo should be present in order to secure the complete oxidation of the tannin before the solution becomes bleached. When solutions of the above strength are used and the titrations carried out very slowly, taking at least five or six minutes for each one, this process serves as one of the best for the estimation of commercial tanning materials; the end reaction, indicated by a change of color from indigo-blue to straw-yellow, being quite distinct.

In testing a sample of bark or leaves, a weight of from 2 to 5 grams should be percolated with petroleum naphtha (boiling below 70° C.) in order to first remove as many substances not tannin as possible, and then the tannin extract should be made by percolating with 80 per cent. alcohol, the alcohol evaporated and replaced by water, this solution filtered and diluted to 200 or 500 cubic centimeters. Ten cubic centimeters of this solution are then titrated under the same conditions as above described. The amount of permanganate required, less the amount necessary for oxidation of the indigo used, is the amount necessary for the oxidation of all reducing substances present in the extract. One hundred cubic centimeters of the latter are now treated with ammonio-cupric or ammonio-zinc acetate, and the tannin precipitated as a compound of tannin and copper or zinc. After standing a few minutes the precipitate is filtered off and the filtrate titrated in the same manner as the original solution. The amount of permanganate required to oxidize the entire oxidizable material of the extract less the amount necessary for the oxidation after the removal of the tannin, gives the amount reduced by the tannin alone.

EXAMINATION OF "HUBBELL'S LAMOKIN FARM STOCK POWDER."

The following is a copy of a part of the claims for this powder. The sample received was in an ordinary cigar-box, price $1.

HUBBELL'S LAMOKIN FARM STOCK POWDER.—The preventive and cure for all diseases of CATTLE, HORSES, SHEEP, SWINE, and for all parasite affections.

It has proved to be also a cure for PLEURO-PNEUMONIA and all other DISEASES OF THE BLOOD, and of the vital organism of live stock of all kinds, and even a cure for the HUMAN SYSTEM—a teaspoonful in a wine-glass of water being a full dose for an adult person.

W. W. HUBBELL, INVENTOR, Lamokin Stock Farm, Appomattox Co., Va.
Post-office address, Concord Station P. O., Campbell Co., Virginia.
Price, one dollar.

The name is said to have been copyrighted in 1880.

A careful analysis gave the following figures:

Sodium chloride (NaCl), common salt	35.10
Magnesium chloride ($MgCl_2$)	.68
Potassium sulphate (K_2SO_4)	1.31
Potassium carbonate (K_2CO_3)	1.84
Iron oxide (Fe_2O_3), Silica (SiO_2), &c	1.47
Sulphur, S	23.24
Ammonium carbonate	5.74
Wood charcoal, estimated	6.00
Organic matter, containing spent cloves and possibly (?) other aromatics	24.62
	100.00

The mineral substances above mentioned which equal less than 2 per cent. were not added as such, but were present as impurities in the common salt or in the ash ingredients of the cloves.

This powder may be quite closely copied by mixing the following substances:

	Parts.
Common salt	6
Sulphur	4
Spent cloves	4
Ammonium carbonate	1
Wood charcoal	1

These are all very cheap materials.

While we have no opinion to express regarding the claims made for this powder it is quite evident that enough is charged to afford a very handsome profit. Common salt is worth from 1 to 2 cents per pound, sublimed sulphur $3\frac{1}{4}$ to 7 cents, and ammonium carbonate 20 to 23 cents. It is impossible to state prices for wood charcoal, or spent cloves, both of which are very cheap.

EXAMINATION OF "HAAS' HOG CHOLERA REMEDY."

Made by "Jos. Haas, V. S,. Indianapolis, Ind. Received from Ezra Stetson, M. D., Neponset, Ill.

A pinkish powder which yields to water an alkaline solution containing soap and a little lime. The following are the analytical results:

Moisture	2.08
Clay	4.26
Iron oxide (Fe_2O_3), traces of aluminium oxide (Al_2O_3)	6.58
Potash (K_2O)	4.25
Sodium chloride (NaCl)	.42
Lime (CaO)	37.25
Magnesia (MgO)	13.66
Carbonic acid (CO_2)	23.53
Sulphuric acid (SO_3)	trace.
Organic matter of soap	7.97
	100.00

The clay and iron oxide were combined as red ocher or colcothar. The following mixture will not vary greatly from the sample:

	Parts.
Powdered soap	10
Potassium carbonate	5
Red ocher	12
Chalk	50
Quicklime	10
Calcined magnesia	13
	100

In place of the first two ingredients might be substituted 15 parts of powdered soap.

We very seriously doubt whether this "remedy" has any real value in treatment of hog cholera.

ANALYSIS OF "PACIFIC MAGIC POLISH."

Received from Frank A. Forrester, San Luis Obispo, Cal.

A white smooth powder, very free from grit, and well adapted for polishing brass, white metal, &c., but probably a little too sharp for silver or gold.

The following is an analysis:

Silica (SiO_2)	70.23
Aluminium oxide (Al_2O_3), with trace of iron oxide (Fe_2O_3)	16.55
Lime (CaO)	1.06
Magnesia (MgO)	.59
Potash (K_2O)	11.32
Moisture and undetermined	.25
	100.00

CONCENTRATED CATTLE FOOD.

Sample received from James O. Adams, Secretary of New Hampshire State Board of Agriculture.

An analysis of this substance gave the following results:

	Per cent.
Common salt, NaCl	10.90
Total albuminoids	7.35
Fats extracted by ether	5.09
Moisture, fiber, ash, digestible carbohydrates	76.66
	100.00

The average composition of flint-corn is:

	Per cent.
Total albuminoids	10.70
Fats	5.16
Digestible carbohydrates	70.19
Moisture, fiber, ash	13.95
	100.00

It appears, therefore, that this "concentrated" food is deficient in albuminoids, the most valuable food constituents in grains. Hence there can be little or no cotton-seed meal in the mixture. There seem to be present corn, oats, and fœnugræcum, together with common salt. This food probably has a little lower nutritive value than good corn meal.

MINERALS, MARLS, AND FERTILIZERS.

Very many samples have been received, and a considerable number of analyses, complete or partial, have been made, in order that advice might be given those sending the samples.

The question as to the fertilizing value of powdered limestone has been frequently presented, and the answer given has been that careful comparative trials are the most valuable guides to the solution of the question. If two contiguous equal portions of the same ground in the same season are used in raising the same crop, and if one portion which has been treated with powdered limestone yields a decidedly greater crop, it is fair to suppose that the added limestone has been beneficial.

It hardly seems probable that the addition of pure limestone (carbonate of calcium) would add to the fertility of a soil already containing a large proportion of the same substance; it might, however, be beneficial to add limestone to soils in which it is really deficient.

Nearly the same remarks apply to the many shell-bearing marls which are received for analysis. It must be remembered, however, that many limestones and marls contain small amounts of potash and phosphates which have a positive value as fertilizers. The amount of these substances in marls is seldom sufficient to warrant transportation for any considerable distance, yet it is probable that the farmer's time and labor would in many cases be compensated by an increase in crops sufficient to repay him for hauling the marl.

Different soils vary so greatly in their composition, and consequently in their needs, that it is not possible to here give advice which shall apply with equal force in each case. Nor is it always possible to tell with certainty from a chemical analysis of a soil just what would be the best treatment to be given it. Certainly much could be properly inferred from such analysis, but we wish especially to state that *the results of actual, carefully conducted experiments will show facts which are worth much more than volumes of theory.*

It must be remembered that field experiments are just as likely to lead to false conclusions as laboratory experiments, unless they are very carefully conducted.

This department will gladly furnish advice at any time in order, if possible, to aid farmers who may wish to make careful trials of different fertilizing materials. The results of the various analyses that have been made are not deemed of sufficient general interest to justify their publication here.

ANALYSIS OF SOILS.

An examination has been made of two soils, sent to this division by Mr. Gill, tea importer of Baltimore, and said to be both suited to the growth of good tea.

"A" is from South Carolina; it is a very dark-colored, sandy soil, containing pieces of half-decayed wood and bark. Of it Mr. Gill says: "It grows a better plant than I have elsewhere seen."

"B" is from the best Cachar plantation in India. It is a very fine, light yellow loam.

	"A."	"B."
Fine soil (passing $\frac{1}{16}$ inch)	96.51	97.48
Coarse soil	3.49	2.52
The fine soil consists of:		
Water	1.460	1.180
Organic and volatile	5.660	5.450
Sand and clay	88.590	82.740
Alumina	2.430	6.890
Iron oxide	.830	3.150
Lime	.320	.152
Magnesia	.137	.403
Potash	.006	.009
Soda	.001	.002
Sulphuric acid	.080	.000
Phosphoric acid	.059	.071
	99.573	100.047

From the above analyses we should conclude that the India soil—"B"—was the better. It is, however, so much heavier than "A," that it may not be suited so well to plants requiring a light sandy soil.

Analyses of Mineral and Potable Waters.

Much has been written regarding the quality of drinking waters, the methods of analysis, and the particular substances which render water unfit for daily use. As an outcome of much discussion and careful experimentation, we are now possessed of simple analytical methods which serve at least to show whether any particular sample of drinking water is likely to prove unwholesome; and there seem to be no well authenticated cases of disease which have been directly caused by drinking water which has withstood the delicate tests that are now applied in analysis.

WELL WATERS.

It may be well to here state what are the usual constituents of ordinary well water. Nearly all well waters contain a greater or lesser amount of *dissolved gases;* of these *oxygen, nitrogen,* and free *carbonic acid* are the principal.

The oxygen and nitrogen are derived from the air; but while the proportion of oxygen to nitrogen in the air is as one to four, the relative amount of oxygen in water is usually much greater. In fact, the oxygen is often present in amount twice that of the nitrogen in air, or as one to two. This greater portion of oxygen in water renders animal life possible, and doubtless greatly aids the purification of the water by the destruction of dissolved or suspended organic matters.

The presence of free carbonic acid in water renders it much more palatable. Perfectly pure water, or water which has been boiled long enough to expel all the dissolved gases, has a very flat, insipid taste. All natural well or spring waters contain dissolved *mineral substances.* The amount of these substances varies greatly, some specimens of water containing only one or two grains per gallon, while others are very heavily charged. In ordinary drinking waters the range is probably between ten and thirty grains in a wine gallon of 231 cubic inches. If much larger amounts are present the sample is usually regarded as a "mineral water." The inorganic substances most frequently present in drinking waters are lime (CaO), magnesia (MgO), potash (K_2O), and and soda (Na_2O), as bicarbonates, sulphates, and chlorides. Next in frequency of occurrence is iron, which is usually dissolved as bicarbonate ($FeCO_3CO_2$), although it is sometimes present as sulphate ($FeSO_4$), especially when its presence is due to the decomposition of iron pyrites (FeS_2) through action of air and water.

If the iron is present as bicarbonate, it will, after a short exposure to the air, begin to deposit a yellow or reddish brown sediment of hydrate of iron ($Fe_2H_6O_6$); this deposit is caused by the escape of the carbonic acid which held the iron in solution, and by the action of the oxygen of the air. So, also, if water be boiled which contains bicarbonates of lime and magnesia, a sediment will soon form of ordinary carbonates of lime and magnesia, which are nearly insoluble in pure water, but are dissolved by water containing carbonic-acid gas.

Now the "hardness" of water depends chiefly on the amount of dissolved salts of lime and magnesia. Hence boiling, which throws part of this lime and magnesia out of solution, tends to make the water "soft." As is well known, a "hard" water is one which forms with ordinary soap an insoluble curdy substance, which is, in reality, nothing but an insoluble lime and magnesia soap, of no use for washing purposes.

In many analyses of "hard" waters it is customary to give figures

for "*temporary hardness*" and "*permanent hardness.*" The sum of these two determinations is "*total hardness,*" and is determined by action of a standard solution of soap on the unboiled water. The "permanent hardness" is determined on the same volume of water after boiling; and "temporary hardness" is found by taking the difference between "total hardness" and "permanent hardness." The total hardness is expressed in degrees from 1 to 16. The latter figure corresponds with 22.86 parts of calcium carbonate in 100,000 parts of water.

Well waters sometimes, though rarely, contain lithium, cæsium, rubidium, or bromine in very small amounts.

In addition to the above-mentioned substances good well waters usually contain very small amounts of *organic matters.*

Probably no other substances have such a direct and positive bearing on the healthfulness of drinking water as these very organic matters. As much, if not more, depends on the quality of these organic substances as upon their quantity.

It seems to be fully proven that decaying nitrogenous substances are more prejudicial to the quality of drinking water than any other form of organic matter. These nitrogenized bodies pass through various stages of decay and are finally converted, in whole or in part, into ammonia and nitrites and nitrates, in which final state they are no longer hurtful.

It must not be inferred from this that the simple detection of ammonia, nitrites, or nitrates is an evidence that the water is good; in fact it is usually a bad sign, unless it can be shown that no other nitrogenized substances are present.

These three substances are a fair measure of the *past contamination* of the water, while the *present impurity* depends on the amount of those nitrogenized bodies which have not yet been converted into these harmless substances. The actual estimation of the weight of these bodies is hardly possible, but it is perfectly practicable to determine the amount of ammonia they can furnish when appropriate methods are used. The ammonia actually present in the water is stated as "*free ammonia*" while that derived from the organic substances present is known as "*albuminoid ammonia.*" Upon the amount of this latter substance may be based, in part, a decision as to the healthfulness of a given sample of water.*

Another method is of value, more in showing the *comparative amount of organic matter*, or the ease with which it may be oxidized. This method depends upon the amount of oxygen (liberated from potassium permanganate) which is necessary to fully oxidize the organic matter in a given volume of water; it is not applicable without correction to waters containing iron in solution.

Considerable care and attention to the matter of time and temperature are necessary in order that the results of this test may be of value. G. W. Wigner† has shown that an increase, either of time or temperature caused the results to be materially increased. The presence of much combined *chlorine* in drinking water is a bad sign if the amount found is greatly in excess of the quantity present in waters from the same vicinity and geological formation which are undoubtedly free from sewerage contamination. If, by comparison with such samples, the suspected sample is found to contain an excessive amount of chlorides there is strong reason to suspect contamination from sewage or cesspools.

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* The "albuminoid ammonia" process of Wanklyn and Chapman is to be recommended.

†Analyst, March, 1881, p. 39.

In the same way the presence of phosphoric acid is a bad sign, especially if the amount exceeds a mere trace.*

It is obviously unsafe to fix definite arbitrary standards by which to judge any and all samples of drinking water; but if comparison of the sample being investigated with water of known healthfulness from the same region, shows the suspected sample to contain a marked excess of any of the above-mentioned suspicious substances, there is great reason to think the sample unhealthful.

The *appearance* of a specimen of drinking water may, or may not, be of value in judging of its healthfulness. Many perfectly clear samples are highly injurious, while, on the other hand, many turbid and unsightly samples are by no means bad. Thus the Potomac water furnished to the city of Washington holds in suspension a small amount of clay which causes the water to be turbid and yellowish; but the health record of the city fails to show any unusual amount of typhoid and dysenteric cases, which are commonly believed to be increased where bad water is drank.

The *purification of drinking waters* by use of household filters is certain, provided the filters are properly constructed and are used intermittently.

The ordinary sand and charcoal filters now extensively used are in nearly every case efficient. The chief point is that the filter should not be used continuously. If water is passed through the filters for several hours, and then the air is allowed to have free access to the filter-bed, the purification of poor drinking waters is prompt and quite complete; but if the filter is used continuously, it soon becomes clogged, the charcoal is rendered practically inert, and the filtered water is merely strained and only partially purified.†

From what has been said it appears that a careful analysis of drinking water is quite sure to be of great value in determining the question as to whether it is fit for domestic uses, provided only that good judgment is used in interpreting the analytical results.

Again, careful filtration through charcoal of poor specimens of water will usually render them fit for use if free access of air to the filter-bed is allowed.

MINERAL WATERS.

Mineral waters usually differ from potable waters in that they contain a much larger amount of dissolved mineral substances. Many contain, in addition, large amounts of carbonic acid or sulphuretted hydrogen gas. For convenience the following somewhat imperfect classification is given. It includes most of the commoner waters now largely used:

Classification of mineral waters.

1. *Saline waters.*—This class includes *cathartic* and *alterative* waters.

a. Cathartic waters frequently owe their effects to the presence of considerable amounts of sulphates, chlorides, or bicarbonates of magnesium or sodium.

b. Alterative waters have frequently an alkaline reaction, and nearly always contain considerable amounts of alkaline salts (largely carbonates or bicarbonates). Of the alkalies, potash and soda are most frequently found in considerable quantities, while lithia, cæsia, rubidia

* See papers by O. Hehner, Analyst, August, 1880, p. 135. J. West Knights, Analyst, November, 1880, p. 195. S. Harvey, Analyst, November, 1880, p. 197.

† See article by Prof. A. B. Prescott, E. M. Reed, and Theo. Hauck, Chem. News, March 15, 1878, p. 107.

are less frequently present and in very much smaller amounts. Rarely iodine, bromine, or fluorine are found in traces.

2. *Chalybeate waters* usually contain iron held in solution as bicarbonate, but under certain conditions the iron may be present partly or wholly as sulphate. These waters, especially the ones containing iron as bicarbonate, are considered to be valuable tonics.

3. *Sulphuretted waters* contain more or less sulphuretted hydrogen gas, which imparts a disagreeable odor and peculiar taste. Many of these waters contain large amounts of mineral matters, and their medicinal effects may be either tonic or alterative, or both. Their external use is frequently beneficial in cutaneous diseases.

It is obvious that the analysis of mineral waters requires especial attention to the determination of the dissolved gases and mineral matter; the determination of the character of the organic matter is less important than in drinking waters.

The habitual use of mineral waters as beverages, without the express advice of a competent physician, is a practice by no means to be recommended. On the contrary, the repeated frequent use of these waters is very likely to lead to derangement of the stomach and the accompanying ailments which it is often supposed the mineral waters will prevent or cure. When intelligently used, however, there is no doubt that many diseases can be either alleviated or entirely cured by the use of mineral waters.

ANALYSES OF WELL AND MINERAL WATERS.

Comparison of Potomac water with water from the well at the Department of Agriculture.

	Parts per million.	
	Well water.	Potomac water.
Free ammonia	0.024	0.016
Albuminoid ammonia	0.042	0.050
Oxygen to destroy organic matter	1.602	1.424
Chlorine in chlorides	17.600	18.000

There is a striking similarity between the two samples, which rather seems to show the well water to be derived from the same source as the Potomac water. The situation of the well is such that it is not improbable that it may be fed by infiltration from the river. Both samples may be considered good for drinking. The Potomac water was the more turbid at that time (October 23, 1880).

REPORT ON THE VARYING COMPOSITION OF GRASSES AND LEGUMINOUS PLANTS AT DIFFERENT STAGES OF DEVELOPMENT.

Although a large number of analyses of single specimens of grasses have been made in the laboratory of the department during previous years, the known variability of composition at different stages of growth pointed to the necessity for the collection and analysis of series, illustrating the life history of the various species, in order to determine their value to the farmer, as far as chemistry can do so, if cut at longer or shorter intervals before complete maturity. No single analysis of a grass grown under restricted conditions of soil and climate can be of so general value as a comparison of the composition of the same grass at intervals in its growth, the results of which would probably hold good for very varying conditions of cultivation.

The series which have been analyzed have been collected, with one exception, on the grounds of the department. Care was used that all specimens should be cut in each series under as like conditions as possi-

ble of soil and surroundings; nevertheless in a few cases the composition seems to have been influenced by variation in the circumstances of growth. Local deposits of manure and rubbish can easily produce such an effect, and often occur in the neighborhood of buildings and cities.

The following species have been examined, with the results given in the tables.

LEGUMINOSÆ:

I. *Trifolium pratense.* Red clover, two sets.
II. *Vicia sativa.* Vetch, two sets.
III. *Medicago sativa.* Lucerne.

GRAMINEÆ:

IV. *Agrostis vulgaris.* Red top, two sets.
V. *Phleum pratense.* Timothy, two sets.
VI. *Dactylis glomerata.* Orchard grass, two sets.
VII. *Alopecurus pratensis.* Meadow foxtail.
VIII. *Poa pratensis.* Blue grass, three sets.
IX. *Poa compressa.* English blue grass.
X. *Bromus unioloides.* Schräders grass.
XI. *Bromus erectus.* Upright chess.
XII. *Holchus lanatus.* Meadow soft grass.
XIII. *Arrhenatherum avenaceum.* Oat grass.
XIV. *Setaria glauca.* Foxtail.
XV. *Anthoxanthum odoratum.* Sweet vernal grass.
XVI. *Festuca ovina.* Sheep's fescue.
XVII. *Lolium Italicum.* Italian rye grass.
XVIII. *Lolium perenne.* Common darnel, rye grass.

Examination and analyses of grasses and leguminous plants.

	I.—TRIFOLIUM PRATENSE.					
	First growth.					After-math.
	No. 1.—Flower head invisible.	No. 32.—Flower head well formed.	No. 38.—In full bloom.	No. 65.—After bloom.	No. 81.—In seed.	No. 84.—Flower head invisible.
When cut	April 19	May 4	May 10	June 1	June 8	June 23
Height in centimeters	25.	38.	51.	60.	70.	20.
Per cent. of water in fresh grass	82.8	82.7	79.9	74.2	73.9	82.3
Water	*7.68	9.45	8.55	8.36	8.15	6.00
Ash	†8.58	8.05	7.60	6.64	6.75	10.55
Fat	7.03	5.25	4.38	4.23	3.65	8.72
N. free extract	42.06	42.30	47.42	45.94	49.90	41.78
Crude fiber	‡10.15	11.85	14.55	18.25	17.55	13.10
N. × 6.25	24.50	23.10	17.50	16.58	14.00	24.85
Ash	9.29	8.89	8.31	7.25	7.35	11.22
Fat	7.62	5.80	4.79	4.62	3.97	3.96
N. free extract	45.56	46.71	51.85	56.13	54.33	44.45
Crude fiber	10.99	13.09	15.91	19.91	19.11	13.93
N. × 6.25	26.54	25.51	19.14	18.09	15.24	26.44
Total nitrogen	4.25	4.08	3.07	2.72	2.44	4.23
Non-albuminoid nitrogen	§.82	1.14	1.14	.21	.61	1.45
Per cent. of N. non-albuminoid	19.3	27.9	37.1	7.7	25.0	34.3
Nutritive ratio	2.0	2.1	3.0	3.0	3.8	1.8

*Duplicate, 7.74. †Duplicate, 8.67, 8.38, 8.50. ‡Duplicate, 10.50. §Duplicate, .82.

Examination and analyses of grasses and leguminous plants—Continued.

	I.—TRIFOLIUM PRATENSE.				II.—VICIA SATIVA.		
	Aftermath.						
	No. 85.—Flower head well formed.	No. 86.—In full bloom.	No. 87.—After bloom.	No. 88.—In seed (brown).	No. 13.—No sign of bloom.	No. 31.—In full bloom.	No. 48.—In bloom and seed.
When cut	June 27	July 1	July 10	July 15	April 23	May 4	May 21
Height in centimeters	37.	40.	40.	40.	30.	35.	67.
Per cent. of water in fresh grass	....	73.4	....	63.7	87.1	86.2	83.9
Water	7.35	7.40	7.20	7.30	6.05	7.85	7.86
Ash	8.25	8.25	6.90	6.20	12.05	10.68	11.44
Fat	3.08	3.60	4.38	4.38	3.90	4.05	3.63
N. free extract	46.87	46.85	52.17	51.57	31.96	35.69	35.42
Crude fiber	15.90	14.65	14.30	16.55	11.23	14.08	18.55
N. × 6.25	18.55	19.25	15.05	14.00	34.81	27.65	23.10
Ash	8.90	8.91	7.43	6.69	12.83	11.59	12.42
Fat	3.33	3.89	4.72	4.72	4.15	4.39	3.94
N. free extract	50.59	50.59	56.22	55.63	34.02	38.73	38.44
Crude fiber	17.16	15.82	15.41	17.86	11.95	15.28	20.13
N. × 6.25	20.02	20.79	16.22	15.10	37.05	30.01	25.07
Total nitrogen	3.21	3.33	2.59	2.42	5.93	4.80	4.02
Non-albuminoid nitrogen	.98	1.14	.36	.67	2.09	1.24	1.47
Per cent. of N. non-albuminoid	30.5	34.2	13.9	27.7	35.3	25.8	36.6
Nutritive ratio	2.7	2.6	3.8	4.0	1.0	1.4	1.7

	III.—MEDICAGO SATIVA.			IV.—AGROSTIS VULGARIS.			
	No. 18.—Young; no buds.	No. 39.—Before bloom.	No. 66.—In bloom. (Aftermath.)	No. 69.—Panicle not out.	No. 70.—Panicle out; closed.	No. 101.—Early bloom.	No. 103.—Full bloom.
When cut	....	....	June 1	June 1	June 1	June 19	June 23
Height in centimeters	15.25	73.	85.	42.	58.	48.	45.
Per cent. of water in fresh grass	80.4	79.3	70.1	67.8	68.1	70.1	61.4
Water	7.30	8.28	6.65	7.15	7.40	6.65	6.45
Ash	10.72	8.92	6.25	7.60	6.80	7.05	6.80
Fat	3.88	3.95	2.63	3.50	3.75	3.38	2.68
N. free extract	38.80	41.40	47.94	50.03	50.12	50.84	53.16
Crude fiber	12.00	17.85	20.78	19.47	19.33	20.20	20.60
N. × 6.25	27.30	19.60	15.75	12.25	12.60	11.88	10.31
Ash	11.56	9.73	6.70	8.19	7.34	7.55	7.27
Fat	4.19	4.30	2.81	3.77	4.05	3.62	2.87
N. free extract	41.86	45.14	51.36	53.88	54.13	54.46	56.82
Crude fiber	12.94	19.46	22.26	20.97	20.87	21.64	22.02
N. × 6.25	29.45	21.37	16.87	13.19	13.61	12.73	11.02
Total nitrogen	4.65	3.42	2.70	2.11	2.18	2.04	1.76
Non-albuminoid nitrogen	1.55	.40	.66	.82	.80	.54	.53
Per cent. of N. non-albuminoid	43.3	11.7	24.4	38.9	36.7	26.4	30.1
Nutritive ratio	1.6	2.3	3.2	4.4	4.3	4.6	5.4

Examination and analyses of grasses and leguminous plants—Continued.

	IV.—AGROSTIS VULGARIS.				
				From poorer soil.	
	No. 104.—Seed in the milk.	No. 105.—Seed hard.	No. 107.—Seed mature.	No. 82.—Panicle spreading.	No. 102.—Early blooming.
When cut	July 1	July 1	July 9	June 16	June 18
Height in centimeters	43.	47.	55.	43.	53.
Water in fresh grass	52.3	51.5	57.0	68.2	58.8
Water	6.05	5.85	5.75	7.25	6.70
Ash	6.20	6.35	5.00	7.80	5.45
Fat	3.30	4.00	2.58	3.60	4.95
N. free extract	56.39	55.43	57.79	53.25	54.57
Crude fiber	18.25	19.45	20.50	19.00	19.05
N. × 6.25	*9.81	8.92	8.38	9.10	9.28
Ash	6.60	6.74	5.30	8.41	5.84
Fat	3.51	4.25	2.74	3.88	5.30
N. free extract	60.02	58.88	61.32	57.41	58.49
Crude fiber	19.43	20.66	21.75	20.49	20.42
N. × 6.25	10.44	9.47	8.89	9.81	9.95
Total nitrogen	1.67	1.52	1.42	1.57	1.59
Non-albuminoid nitrogen	.36	.18	.09	.28	.32
Per cent. of N. non-albuminoid	21.6	11.8	6.3	17.8	20.1
Nutritive ratio	6.1	6.7	7.2	6.2	6.4

	V.—PHLEUM PRATENSE.					
	No. 67.—Spike invisible.	No. 68.—Spike visible.	No. 89.—Before bloom.	No. 90.—Early bloom.	No. 92.—Full bloom.	No. 93.—Early seed.
When cut	June 1	June 1	June 23	June 23	June 18	June 18
Height in centimeters	42.	62.	45.	60.	58.	52.
Water in fresh grass	70.7	71.9	67.5	64.9	67.2	77.8
Water	7.85	8.80	6.80	5.60	6.30	5.95
Ash	8.00	5.85	9.15	5.70	5.30	†9.90
Fat	4.20	3.10	3.38	3.63	3.35	3.20
N. free extract	50.05	52.22	50.51	54.01	55.22	47.09
Crude fiber	18.35	19.18	20.53	21.43	20.55	22.48
N. × 6.25	11.55	10.85	9.63	9.63	9.28	11.38
Ash	8.68	6.41	9.82	6.04	5.66	10.53
Fat	4.56	3.40	3.63	3.85	3.58	3.40
N. free extract	54.31	57.26	54.19	57.21	58.93	50.07
Crude fiber	19.91	21.03	22.03	22.70	21.93	22.90
N. × 6.25	12.54	11.90	10.33	10.20	9.90	12.10
Total nitrogen	2.01	1.86	1.65	1.63	1.58	1.93
Non-albuminoid nitrogen	‡.70	.55	.36	.30	.38	.51
Per cent. of N. non-albuminoid	35.0	29.5	21.8	18.4	24.0	26.4
Nutritive ratio	4.7	5.1	5.6	6.0	6.3	4.4

*Duplicate, 9.93. †Duplicate, 10.20. ‡Duplicate, .70.

Examination and analyses of grasses and leguminous plants—Continued.

	V.—Phleum pratense. Poorer soil.		VI.—Dactylis glomerata.			
	No. 77.—In bloom.	No. 91.—Full bloom.	No. 11.—Panicle not out.	No. 29.—Panicle closed.	No. 44.—Full bloom.	No. 62.—After bloom.
When cut	June 4	July 1	April 23	May 4	May 13	June 1
Height in centimeters	60.	70.	35.	55.	87.	125.
Water in fresh grass	63.4	71.9	78.8	79.3	77.3	73.5
Water	7.05	6.10	5.75	7.35	6.40	8.84
Ash	6.10	5.30	9.70	7.65	7.55	8.21
Fat	3.67	2.80	3.88	2.90	3.03	2.58
N. free extract	53.43	57.35	47.94	50.99	50.32	48.00
Crude fiber	21.87	21.45	17.68	21.48	23.78	24.85
N. × 6.25	7.88	7.00	15.05	9.63	8.92	7.52
Ash	6.56	5.64	10.29	8.26	8.07	9.01
Fat	3.95	2.98	4.12	3.13	3.24	2.83
N. free extract	57.48	61.08	50.86	55.04	53.76	52.65
Crude fiber	23.53	22.84	18.76	23.18	25.40	27.26
N. × 6.25	8.48	7.46	15.97	10.39	9.53	8.25
Total nitrogen	1.36	1.19	2.49	1.63	1.53	1.32
Non-albuminoid nitrogen	.30	.36	1.01	*.00	.16	.33
Per cent. of N. non-albuminoid	22.0	30.3	40.6	0.0	10.5	25.0
Nutritive ratio	7.2	8.6	3.4	5.6	6.0	6.7

	VI.—Dactylis glomerata. Later growth.			VII.—Alopecurus pratensis.			
	No. 97.—In bloom.	No. 98.—Late bloom.	No. 96.—Seed nearly ripe.	No. 6.—Head just appearing.	No. 7.—Before bloom.	No. 24.—In bloom.	No. 43.—After bloom.
When cut	June 18	June 23	July 1	April 19	April 19	May 1	May 12
Height in centimeters	80.	75.	75.				
Water in fresh grass	66.9	60.2	62.3	77.1	76.7	60.0	66.6
Water	6.25	6.65	6.40	‡8.75	§9.83	7.70	8.58
Ash	8.10	†5.60	6.30	‖8.40	¶7.12	7.15	7.47
Fat	3.73	3.38	3.13	4.28	4.02	3.10	3.20
N. free extract	47.06	53.52	53.86	47.60	46.58	50.12	49.69
Crude fiber	23.13	22.80	23.48	**16.62	20.20	21.95	23.18
N. × 6.25	11.73	8.05	6.83	14.35	12.25	9.98	7.88
Ash	8.64	6.00	6.73	9.21	7.90	7.75	8.17
Fat	3.98	3.62	3.34	4.69	4.46	3.36	3.50
N. free extract	50.20	57.34	57.54	52.16	51.66	54.30	54.35
Crude fiber	24.67	24.42	25.09	18.21	22.40	23.78	25.36
N. × 6.25	12.51	8.62	7.30	15.73	13.58	10.81	8.62
Total nitrogen	1.99	1.38	1.16	2.52	2.17	1.73	1.38
Non-albuminoid nitrogen	.77	.42	.45	.66	.53	.00	.07
Per cent. of N. non-albuminoid	38.7	30.4	38.8	38.2	40.9	0.0	5.0
Nutritive ratio	4.3	7.1	8.3	3.6	4.1	5.3	6.7

* Duplicate, 0.3. † Duplicate, 5.40. ‡ Duplicate, 8.70 and 8.10. § 10.00 and 9.65. ‖ 8.60, 8.20. ¶ 16.90, ** 7.10 and 7.15.

Examination and analyses of grasses and leguminous plants—Continued.

	VIII.—Poa pratensis. (Grown on the department grounds.)					
	Set No. 1.—Grown on good soil.				Set No. 2.—Grown on poor soil.	
	No. 12.—Panicle just visible.	No. 25.—Panicle spreading.	No. 49.—Full bloom.	No. 79.—In seed.	No. 20.—Panicle closed.	No. 35.—In full bloom.
Date of cutting	April 23	May 1	May 21	June 5	April 27	May 8
Height in centimeters	20.	30.	70.	70.	....	65.
Water in fresh grass	76.7	70.8	71.9	55.9	....	69.0
Water	6.65	7.15	6.98	7.55	6.95	6.00
Ash	7.53	5.17	7.72	5.90	6.15	6.60
Fat	4.56	3.78	3.63	3.93	3.65	2.68
N. free extract	45.50	47.65	47.84	48.57	51.47	53.44
Crude fiber	17.20	21.20	22.10	22.50	20.40	23.93
N. × 6.25	18.56	15.05	11.73	11.55	11.38	7.35
Ash	8.07	5.57	8.30	6.38	6.61	7.02
Fat	4.88	4.07	3.90	4.25	3.92	2.85
N. free extract	48.74	51.32	51.43	52.54	55.32	56.85
Crude fiber	18.43	22.83	23.76	24.34	21.92	25.46
N. × 6.29	19.88	16.21	12.61	12.49	12.23	7.82
Total nitrogen	3.18	2.68	2.01	2.00	1.96	1.28
Non-albuminoid nitrogen	.48	.30	.02	.37	.12	.10
Per cent. of N. non-albuminoid	15.1	11.2	1.0	18.5	6.1	7.8
Nutritive ratio	2.7	3.4	4.4	4.5	4.8	7.6

	Poa pratensis. (Grown on the department grounds.)			Poa pratensis.		
	Set No. 3.—Grown on poor soil; wayside.			Set No. 4, from J. D. Waldo, Quincy, Ill.		
	No. 75.—After bloom; brown.	No. 46.—Full bloom.	No. 80.—In seed; brown.	No. 133.—Before bloom.	No. 130.—In bloom.	No. 128.—After bloom.
Date of cutting	June 1	May 19	June 8	May 10	May 17	May 27
Height in centimeters	65.	70.	75.	....	....	....
Water in fresh grass	55.4	66.2	54.6	....	....	....
Water	7.35	6.15	7.45	6.15	5.95	5.15
Ash	6.70	7.25	5.75	7.90	7.37	8.60
Fat	3.63	3.20	3.25	4.68	3.55	3.13
N. free extract	51.99	51.92	54.21	42.55	45.51	49.81
Crude fiber	22.10	21.68	22.53	20.53	*23.45	†21.58
N. × 6.25	8.23	9.80	6.81	18.19	14.19	11.73
Ash	7.23	7.73	6.21	8.42	7.82	9.07
Fat	3.92	3.41	3.51	4.99	3.77	3.30
N. free extract	56.12	55.32	58.58	45.34	48.39	52.51
Crude fiber	23.85	23.10	24.34	21.87	24.93	22.75
N. × 6.25	8.88	10.44	7.36	19.38	15.09	12.37
Total nitrogen	1.42	1.67	1.18	3.10	2.41	1.97
Non-albuminoid nitrogen	.25	.14	.15	.63	.51	.35
Per cent. of N. non-albuminoid	17.6	8.4	12.7	20.3	21.1	17.8
Nutritive ratio	6.8	5.6	8.4	2.6	3.5	4.6

* Duplicate, 23.20. †Duplicate, 22.25.

Examination and analyses of grasses and leguminous plants—Continued.

	IX.—POA COMPRESSA. (Poor soil.)				X.—BROMUS UNILOIDES.		
	No. 60.—Panicle not out.	No. 61.—Panicle well out.	No. 83.—In bloom.	No. 95.—After bloom.	No. 10.—Panicle not out.	No. 30.—Panicle closed.	No. 45.—Full bloom.
When cut	June 1	June 1	June 17	June 23	April 23	May 4	May 13
Height in centimeters	14.	28.	30.	30.	35.	64.	76.
Water in fresh grass	67.9	68.7	70.7	51.8	80.6	75.4	79.4
Water	8.29	7.50	6.35	6.40	7.65	7.80	7.10
Ash	7.11	6.30	5.70	4.80	9.83	8.25	8.60
Fat	4.85	4.08	4.23	3.60	4.65	3.10	3.68
N. free extract	53.27	51.04	54.49	59.80	45.00	47.05	47.81
Crude fiber	16.68	19.70	17.35	17.00	17.12	20.50	21.08
N. ×6.25	9.80	11.38	11.88	8.40	15.75	13.30	11.73
Ash	7.75	6.81	6.08	5.13	10.65	8.95	9.26
Fat	5.29	4.41	4.52	3.85	5.03	3.44	3.96
N. free extract	58.08	55.18	58.18	63.89	48.73	51.03	51.46
Crude fiber	18.19	21.30	18.53	18.16	18.54	22.22	22.69
N. × 6.25	10.69	12.30	12.69	8.97	17.05	14.36	12.63
Total nitrogen	1.71	1.97	2.03	1.43	2.73	2.31	2.02
Non-albuminoid nitrogen	*.10	.52	†.45	.35	1.06	.55	.34
Per cent. of N. non-albuminoid	5.8	26.4	22.2	24.5	38.8	23.8	16.8
Nutritive ratio	5.9	4.8	4.0	7.5	3.2	3.8	4.4

	X.—BROMUS UNILOIDES.		XI.—BROMUS ERECTUS.				
	No. 63.—After bloom.	No. 64.—In seed, brown.	No. 22.—Very young.	No. 37.—Before bloom.	No. 40.—Before bloom.	No. 47.—Early bloom.	No. 72.—After bloom.
When cut	June 1	June 1	April 27	May 8	May 12	May 19	June 1
Height in centimeters	76.	85.	35.	60.	68.	68.	75.
Water in fresh grass	67.5	64.7	85.5	74.3	72.2	63.7	....
Water	7.90	7.05	7.90	8.35	7.88	6.28	6.60
Ash	6.15	7.95	7.95	6.65	6.82	7.22	7.95
Fat	2.18	1.95	3.38	3.00	3.43	2.63	2.73
N. free extract	50.46	55.50	41.69	47.67	49.17	52.66	52.59
Crude fiber	23.33	‡18.45	24.55	23.13	22.55	22.98	22.08
N. × 6.25	9.98	9.10	14.53	11.20	10.15	8.23	8.05
Ash	6.68	8.55	8.63	7.26	7.40	7.70	8.51
Fat	2.37	2.10	3.67	3.27	3.72	2.81	2.92
N. free extract	54.79	59.71	45.27	52.01	53.38	56.19	56.32
Crude fiber	25.33	19.85	26.65	25.24	24.48	24.52	23.64
N. × 6.25	10.83	9.79	15.78	12.22	11.02	8.78	8.61
Total nitrogen	1.74	1.57	2.52	1.95	1.76	1.41	1.38
Non-albuminoid	.35	.33	.43	.24	.09	.34	.40
Per cent. of N. non-albuminoid	20.1	21.0	17.1	12.3	5.1	24.1	29.0
Nutritive ratio	5.3	6.3	3.1	4.8	5.2	6.7	7.0

* Duplicate, .10. † Duplicate, .42. ‡ Duplicate, 19.10.

Examination and analyses of grasses and leguminous plants—Continued.

	XII.—HOLCHUS LANATUS.		XIII.—ARRHENATHERUM AVENACEUM.		XIV.—SETARIA GLAUCA.	
	No. 21.—Very young.	No. 53.—Late bloom.	No. 54.—Full bloom.	No. 76.—After bloom.	No. 108.—Very young.	No. 109.—Early flowering.
When cut	April 2	May 25	May 25	June 4	July 1	July 24
Height in centimeters	....	72.	85.	60.	50.	80.
Water in fresh grass	82.3	50.6	62.3	74.4	74.2	68.4
Water	9.45	7.43	6.27	8.05	4.55	5.05
Ash	9.04	7.62	7.43	7.25	10.35	6.90
Fat	4.10	3.60	3.78	3.85	2.23	2.53
N. free extract	49.33	51.39	51.49	47.59	45.93	52.49
Crude fiber	16.88	23.15	22.80	19.78	20.70	24.45
N. × 6.25	11.20	6.81	8.23	13.48	*16.24	8.58
Ash	9.98	8.23	7.93	7.88	10.84	7.27
Fat	4.53	3.89	4.03	4.19	2.34	2.66
N. free extract	54.48	55.52	54.93	51.76	48.12	55.28
Crude fiber	18.64	25.01	24.33	21.51	21.68	25.75
N. × 6.25	12.37	7.35	8.78	14.66	17.02	9.04
Total nitrogen	1.98	1.30	1.41	2.35	2.72	1.44
Non-albuminoid nitrogen	.21	.60	.15	.96	1.00	.41
Per cent. of N. non-albuminoid	10.6	46.2	10.6	40.9	36.8	28.5
Nutritive ratio	4.8	8.1	6.7	2.8	3.0	6.4

	XV.—ANTHOXANTHON ODORATUM.				XVI.—FESTUCA OVINA.	
	No. 26.—Very young.	No. 27.—Full bloom.	No. 94.—After bloom.	No. 100.—After bloom; brown.	No. 23.—Young.	No. 36.—Before bloom.
When cut	May 1	May 1	June 19	July 19	April 27	May 8
Height in centimeters	15.	40.	45.	55.	25.	36.
Water in fresh grass	76.9	78.8	69.9	53.4	70.0	65.4
Water	7.50	7.65	6.45	6.80	8.40	5.96
Ash	5.91	6.55	6.80	5.40	5.93	5.09
Fat	3.95	3.10	4.55	3.80	3.95	3.40
N. free extract	56.96	54.90	49.96	54.07	49.47	53.72
Crude fiber	15.88	19.05	19.80	23.30	18.60	23.60
N. × 6.25	9.80	8.75	12.44	6.63	13.65	8.23
Ash	6.39	7.09	7.27	5.79	6.47	5.41
Fat	4.27	3.36	4.86	4.08	4.31	3.61
N. free extract	61.58	59.45	53.40	58.02	54.00	57.13
Crude fiber	17.17	20.63	21.17	25.00	20.31	25.10
N. × 6.25	10.59	9.47	13.30	7.11	14.91	8.75
Total nitrogen	1.70	1.52	2.13	1.14	2.38	1.40
Non-albuminoid nitrogen	.06	.15	.51	.35	.12	.06
Per cent. of N. non-albuminoid	3.5	9.9	23.9	30.7	5.0	4.3
Nutritive ratio	6.2	6.6	4.4	8.7	3.9	6.9

* Duplicate, 16.41.

Examination and analyses of grasses and leguminous plants—Continued.

	XVI.—FESTUCA OVINA.			XVII.—LOLIUM ITALICUM.			
	No. 41.—Before bloom.	No. 50.—In bloom.	No. 71.—After bloom.	No. 19.—Head invisible.	No. 51.—Head just out.	No. 55.—Full bloom.	No. 78.—After bloom.
When cut	May 12	May 21	June 1	April 27	May 21	May 26	June 4
Height in centimeters	45.	40.	47.	55.	75.	90.	92.
Water in fresh grass	67.0	53.7	53.9	82.3	82.7	78.0	71.5
Water	5.85	6.25	7.85	7.00	8.25	5.82	7.82
Ash	5.65	5.25	6.05	12.35	10.45	10.38	8.08
Fat	3.23	2.35	2.83	4.55	3.50	2.18	3.67
N. free extract	52.20	54.57	52.61	39.10	44.72	48.72	49.60
Crude fiber	24.15	22.30	22.08	16.88	19.95	19.25	20.15
N. × 6.25	8.92	9.28	8.58	20.12	13.13	*13.65	10.68
Ash	6.00	5.60	6.57	13.28	11.39	11.02	8.76
Fat	3.43	2.51	3.07	4.89	3.81	2.32	3.98
N. free extract	55.44	58.20	57.09	42.04	48.74	51.73	53.81
Crude fiber	25.65	23.79	23.96	18.15	21.75	20.44	21.86
N. 6.25	9.48	9.90	9.31	21.64	14.35	14.49	11.59
Total nitrogen	1.52	1.58	1.49	3.46	2.29	2.32	1.85
Non-albuminoid nitrogen	.16	.27	.27	.67	.39	.18	.43
Per cent. of N. non-albuminoid	10.5	17.1	18.1	19.8	17.0	7.8	23.2
Nutritive ratio	6.2	6.1	6.5	2.2	3.7	3.7	5.0

	XVIII.—LOLIUM PERENNE.				
	No. 28.—Head invisible.	No. 33.—Head invisible.	No. 34.—Head well out.	No. 42.—Before bloom.	No. 73.—After bloom.
When cut	May 1	May 4	May 4	May 12	June 1
Height in centimeters	35.	28.	30.	55.	52.
Water in fresh grass	78.6	82.4	74.0	76.4	63.1
Water	7.00	7.75	7.05	6.60	7.95
Ash	8.05	8.75	7.40	7.85	6.90
Fat	3.33	4.00	3.38	3.50	2.43
N. free extract	53.67	50.82	52.75	51.30	52.32
Crude fiber	17.10	16.61	19.10	22.35	23.40
N. × 6.25	10.85	12.08	10.32	8.40	7.00
Ash	8.66	9.48	7.96	8.40	7.50
Fat	3.58	4.34	3.64	3.75	2.64
N. free extract	57.70	55.08	56.75	54.93	56.84
Crude fiber	18.39	18.00	20.55	23.93	25.42
N. × 6.25	11.67	13.10	11.10	8.99	7.60
Total nitrogen	1.87	2.09	1.78	1.43	1.21
Non-albuminoid nitrogen	.28	.39	.33	.09	....
Per cent. of N. non-albuminoid	15.0	18.7	18.5	6.3	....
Nutritive ratio	5.3	4.5	5.4	6.5	7.8

* Duplicate, 13.48.

CONCLUSIONS DRAWN FROM THE PRECEDING TABLES.

LEGUMINOSÆ.

I.—*Trifolium pratense.* Common red clover.

As the plant approaches maturity, the water in the fresh grass decreases; the ash decreases; the fat decreases; the albuminoids decrease; the crude fiber increases; the carbhydrates increase. The non-albuminoid nitrogen increases till full bloom, then drops suddenly, but increases again at maturity.

In the aftermath the same relative changes take place, and the absolute composition varies very slightly from the first growth.

II.—*Vicia sativa.* Common vetch.

The same changes are apparent as in *Trifolium pratense.* The ash remains nearly constant, and owing to the smaller number of specimens examined the change in the non-albuminoid nitrogen is not as plainly shown, but the diminution at one period in the growth with an increase afterwards appears, as in the previous set.

III.—*Medicago sativa.* Lucerne.

The regularity of the changes seen in the other leguminous plants is shown here in a very striking manner. It seems quite probable, then, that the leguminous plants follow pretty closely the rule, that as the plant matures, water, ash, fat, and albuminoids decrease; carbhydrates and fiber increase. The non-albuminoid nitrogen has a period when it falls to a small amount, increasing again later, so that it is at its highest, as a rule, early and late in the growth of the plants.

GRAMINEÆ.

IV.—*Agrostis vulgaris.* Red top.

During the gradual development of the grass, covered by seven specimens, there is apparent—

The regular decrease of ash and albuminoids, a variable percentage of fat, a practical though not entirely regular increase of crude fiber and carbhydrates. The non-albuminoid nitrogen decreases with great regularity to maturity.

Analyses 82 and 102, from a different locality and poorer soil, show the effect of the latter in decreasing the albuminoids.

V.—*Phleum pratense.* Timothy.

In this grass are to be noted—

The practical but somewhat irregular decrease in the ash.

The regular decrease in fat and albuminoids, the carbhydrates changing very slightly.

The non-albuminoid nitrogen shows the same changes seen in the leguminous plants, a decrease until about the time of bloom or after, followed by an increase at maturity.

The analysis No 93, of a specimen in "early seed," does not conform entirely to the rest of the series, and the reason may be that it was affected by some variation in its surroundings not influencing the others. It is allowed to remain for what it is worth, and as showing the possible accidental variations in the specimens collected.

VI.—*Dactylis glomerata.* Orchard grass.

The regularity of the increase of some and decrease of other constituents is very marked in both early and late growth. In this species the non-albuminoid nitrogen disappears early in the growth of the plant to increase again later. In the set of later growth it is seen to be present in greater amount as was the case with the aftermath of clover.

VII.—*Alopecurus pratensis.* Meadow foxtails.

Strikingly regular in the decrease of ash, fat, and albuminoids, and the increase of fiber.

The non-albuminoid nitrogen disappears at bloom to appear again at seed time.

VIII.—*Poa pratensis.* Blue grass.

Set No. 1, grown in good soil, shows the usual variations.

Set No. 2, from poor soil, is irregular, doubtless owing to lack of similarity in surroundings.

Set No. 3.—There being only two analyses, little is apparent but the increase in non-albuminoid nitrogen after bloom.

Set No. 4, from Illinois, is abnormal in the increase of ash and decrease of fiber in the oldest specimen. In other respects the usual increase and decrease appears. The proportion of non-albuminoid nitrogen in all the samples is very small.

IX.—*Poa compressa.*

This grass is apparently abnormal in the fact that the youngest specimen contains less non-albuminoid nitrogen and fiber than any of the others, and less total nitrogen than any but the mature plant. The reason of this is not easily explained. Duplicates of the determinations show that they are correct. There is, too, more water in the grass at bloom than at other times, a fact which may have been owing to the time of collection or dew on the specimen when it was weighed as brought from the field.

X.—*Bromus unioloides.*

Shows the usual variations except that the last determination of fiber is abnormally low. The fat diminishes rapidly and to a small amount.

XI.—*Bromus erectus.*

The abnormal point in this grass is the decrease of cellulose as the plant approaches maturity. In other respects the usual changes occur.

XII, XIII, and XIV.—*Holchus lanatus*, meadow soft grass; *Arrhenatherum avenaceum*, oat grass; and *Setaria glauca*, foxtail.

The small number of analyses prevents any extended interpretation, but the usual changes are apparent.

XV.—*Anthoxanthum odoratum.* Sweet vernal grass.

In this grass a remarkable rise in non-albuminoid nitrogen toward maturity is shown from 3.5 per cent. in the "very young," to 30.7 per cent. "after bloom." This shows that no rule is absolute, but that different species vary in quite different ways as was seen in the fiber of *Bromus erectus.*

XVI.—*Festuca ovina.*

In this grass, as in the last, the non-albuminoid nitrogen increases steadily with the age of the plant. The fiber does not show the usual regularity of increase, and in many respects the grass seems an abnormal one. The specimens were collected on poor soil, where the grass grew only at intervals, in clumps, and in a rather stunted condition.

XVII.—*Lolium Italicum.* Italian rye grass.

The large amount of ash and water in this grass is striking. The non-albuminoid nitrogen varies in the usual manner, and is present in perhaps less than the average amount. The albuminoids are high, and fiber not above the average, making it altogether a very succulent and nutritive grass, if cut in full bloom.

XVIII.—*Lolium perenne.*

The non-albuminoid nitrogen is small in amount, and diminishes with the age of the plant. The other constituents vary as is usual, and show the composition of the grass to be an average one.

GENERAL CONCLUSIONS.

From the results in the case of each species the following conclusions can be drawn, which are, more or less, applicable to all. As a grass grows older, the amount of—

WATER *decreases*:
ASH *decreases;*
FAT *decreases;*
ALBUMINOIDS *decrease;*
CARBHYDRATES *increase;*
CRUDE FIBER *increases;*
NON-ALBUMINOID NITROGEN *decreases* till bloom or after bloom, when it is at its lowest, and then *increases* again during the formation of the seed.

There are exceptions to these rules, and marked ones, but in the majority of cases the increase of certain constituents and decrease of others follows this general law. There are almost no exceptions to the fact that the amount of water decreases. The ash is a more variable constituent, being easily influenced by local causes. Fat is somewhat irregular, but a decrease is usually quite apparent, and often very marked.

The carbhydrates, being more dependent on the variations of other constituents, show great irregularities, but the tendency is as a rule toward increase.

The albuminoids show no good exceptions to the rule of decrease. Where any increase appears in the analysis it is probably owing to different conditions of growth in the samples in hand.

The fiber shows at times a reversal of the rule of increase, as is seen in *Bromus erectus*, but the decrease is never large.

It is the non-albuminoid nitrogen that shows the most important variations. In *Agrostis vulgaris* the decrease continues to maturity. In *Anthoxanthon odoratum* and *Festuca ovina* it increases toward maturity, with no apparent explanation. The exceptions are not numerous enough, however, to interfere with the general rules of change.

Further examination of these conclusions leads to the inquiry why the non-albuminoid nitrogen, which probably occurs largely as amides increases in amount toward the time of seed formation. It has been suggested that the presence of amides is a sign of the transfer of albumen from one portion of the plant to another, and if this is so it may be supposed that late in the growth of the plant the amides are developed in larger amounts to transfer as much albumen as possible to the newly forming seed.

Kellner's observation,* which showed the diminution in the amount of amides with the age of the plant, were not extended far enough to show their ultimate increase, and the fact that this takes place shows the importance to the farmer of cutting hay before this breaking up of albumen into amides and carbhydrates, if the usually received ideas of the small nutritive value of the latter hold good.

It is apparent, then, that in most cases the time of bloom or thereabout is the fittest for cutting grasses in order to obtain the most nourishment and largest relatively profitable crop, and for the following reasons: The amount of water in the grass has diminished and the shrinkage will therefore be less. The weight of the crop cut will be largest in proportion to the nutritive value of its constituents. The amount of nitrogen not present as albuminoids will be at its lowest point; fiber will not be so excessive as to prevent digestion, and the nutritive ratio will be more advantageous.

If cut earlier the shrinkage is larger although the fiber is less and albumen a little larger. The palatability may be increased but the total nutrients to the acre will not be so large, and the nutritive ratio will be more abnormal.

The disadvantages of late cutting are evident in the increase of fiber destroying the digestibility of the nutriments and the falling off of albumen by conversion into amides. This is not made up by the larger crop cut.

The composition of the aftermath closely resembles that of the first growth, but in the specimens which were examined the absolute amount of the non-albuminoid nitrogen seemed considerably greater in the aftermath.

METHOD OF ANALYSIS.

All the determinations have been made by the methods described in previous reports with the exception of the fiber. For this estimation a modification of the usual "Weende" procedure has been substituted for the sake of greater uniformity in treatment.

The grasses have been treated alternately with 5 per cent. acid and alkali on a steam bath holding a large number of analyses at a time (30). By experiment it was found that two hours with each reagent in the

*Report of Department of Agriculture, 1879, page 108.

bath at about 90° was equivalent to the usual boiling of one hour in the "Weende" method, and greater uniformity could be obtained in the results.

The ulbuminoid nitrogen was determined by the method of A. Stützer (*Journal für Landwirthschaft*, 1880), by treatment with distilled water containing a little lactic acid and precipitation of the dissolved albumen by cupric hydrate. The accuracy of this method has been shown by careful work of Stützer and confirmed by our own results. During the analysis duplicates have been made in many instances where the percentages seemed abnormal, but in no case has it been found necessary to change the first result.

The cases in which two determinations have been made are marked with an asterisk.

ANALYSES OF SINGLE SPECIMENS OF GRASSES FROM VARIOUS LOCALITIES.

In the following table a number of analyses of grasses are given, mostly collected at full bloom in various parts of the country. No comment seems necessary.

Analyses of grasses.

	GROWN AT EASTERN EXPERIMENTAL FARM, WEST GROVE, CHESTER COUNTY, PENNSYLVANIA.					
	No. 120.—Medicago sativa.	No. 118.—Trifolium pratense.	No. 135.—Agrostis vulgaris.	No. 138.—Poa pratensis.	No. 134.—Poa compressa.	No. 140.—Poa alsodes.
Development	Full bloom	Full bloom	Full bloom	Full bloom	Full bloom	Full bloom
When cut	June 12	June 12	July 1	May 26	June 10	June 2
Height in centimeters	....	....	....	....	....	....
Water in fresh grass	....	....	....	....	....	....
Water	4.75	6.85	6.30	5.05	6.30	6.45
Ash	9.35	7.05	6.45	7.10	7.35	8.80
Fat	2.70	3.15	3.10	4.35	3.60	3.83
N. free extract	47.03	48.28	51.14	50.40	54.79	48.09
Crude fiber	21.13	19.63	23.73	19.60	19.58	19.88
N. × 6.25	15.04	15.04	9.28	13.50	8.38	12.95
Ash	9.82	7.57	6.88	7.48	7.85	9.41
Fat	2.83	3.38	3.31	4.58	3.84	4.09
N. free extract	49.38	51.83	54.58	53.08	58.47	51.41
Crude fiber	22.18	21.07	25.33	20.64	20.90	21.25
N. × 6.25	15.79	16.15	9.90	14.22	8.94	13.84
Total nitrogen	2.52	2.60	1.58	2.27	1.43	2.21
Non-albuminoid nitrogen	.88	1.01	.80	.47	.38	.32
Per cent. of N. non-albuminoid	35.0	30.9	50.7	20.8	26.9	14.5
Nutritive ratio	3.3	3.4	5.8	4.1	6.9	4.0

Analyses of grasses—Continued.

	GROWN AT EASTERN EXPERIMENTAL FARM, WEST GROVE, CHESTER COUNTY, PENNSYLVANIA.					
	No. 123.—Phleum pratense.	No. 112.—Panicum anceps.	No. 113.—Panicum Crus Galli.	No. 139.—Panicum sanguinale.	No. 116.—Setaria glauca.	No. 121.—Setaria Italica.
Development	Full bloom	Full bloom	Full bloom	Full bloom	Full bloom	Full bloom
When cut	June 20	July 31	Aug. 25	Aug. 11	Aug. 11	July 24
Height in centimeters						
Water in fresh grass						
Water	5.95	4.95	5.70	7.00	5.50	6.00
Ash	4.75	5.40	11.15	10.65	7.50	7.05
Fat	3.03	1.73	2.35	3.03	2.90	2.55
N. free extract	53.81	59.49	45.04	47.02	55.32	52.43
Crude fiber	23.88	19.85	23.88	21.30	20.73	23.05
N. × 6.25	8.58	8.58	11.88	11.00	8.05	8.92
Ash	5.05	5.68	11.82	11.45	7.94	7.50
Fat	3.22	1.82	2.49	3.26	3.06	2.71
N. free extract	57.22	62.59	47.77	50.56	58.54	55.78
Crude fiber	25.39	20.88	25.32	22.90	21.94	24.52
N. × 6.25	9.12	9.03	12.60	11.83	8.52	9.49
Total nitrogen	1.46	1.44	2.02	1.89	1.37	1.52
Non-albuminoid nitrogen	.41	.44	.80	.81	.39	.51
Per cent. of N. non-albuminoid	28.5	30.7	39.5	42.6	28.5	33.6
Nutritive ratio	6.6	7.1	4.0	4.5	7.2	6.2

	GROWN AT EASTERN EXPERIMENTAL FARM, WEST GROVE, CHESTER COUNTY, PENNSYLVANIA.					
	No. 142.—Muhlenbergia diffusa.	No. 126.—Muhlenbergia Mexicana.	No. 129.—Dactylis glomerata.	No. 117.—Anthoxanthon odoratum.	No. 114.—Lolium perenne.	No. 122.—Triticum repens.
Development	Full bloom	Full bloom	Full bloom	Full bloom	Full bloom	Full bloom
When cut	Aug. 25	Aug. 23	May 19	May 11-24	May 26	June 12
Height in centimeters						
Water in fresh grass						
Water	5.20	5.35	5.95	5.65	5.55	4.55
Ash	15.55	4.10	5.95	5.50	5.75	5.95
Fat	3.25	2.55	2.50	2.80	2.68	3.35
N. free extract	44.89	61.96	51.67	51.15	60.39	55.12
Crude fiber	20.80	21.48	25.88	24.05	17.25	22.98
N. × 6.25	10.31	4.56	8.05	10.85	8.38	8.05
Ash	16.40	4.33	6.33	5.83	6.09	6.23
Fat	3.43	2.69	2.66	2.97	2.84	3.51
N. free extract	47.35	65.47	54.94	54.21	63.94	57.75
Crude fiber	21.94	22.69	27.51	25.49	18.26	24.08
N. × 6.25	10.88	4.82	8.56	11.50	8.87	8.43
Total nitrogen	1.74	.77	1.37	1.84	1.42	1.35
Non-albuminoid nitrogen	.29	.18	.51	.66	.47	.62
Per cent. of N. non-albuminoid	17.0	23.4	37.2	35.9	33.1	45.9
Nutritive ratio	4.7	14.1	6.7	5.0	7.5	7.3

Analyses of grasses—Continued.

	GROWN AT EASTERN EXPERIMENTAL FARM, WEST GROVE, CHESTER COUNTY, PENNSYLVANIA.				
	No. 111.—Festuca elatior.	No. 119.—Glyceria nervata.	No. 141.—Andropogon furcatus.	No. 115.—Tripsacum dactyloides.	No. 127.—Paspalum læve.
Development	Full bloom	Full bloom	Full bloom	Full bloom	Full bloom
When cut	June 2	June 2	Sept. 2	Aug. 11	Aug. 23–29
Height in centimeters	....	....	....	....	....
Water in fresh grass	....	....	....	....	....
Water	4.65	4.20	4.75	5.35	5.85
Ash	7.70	7.60	12.90	5.05	6.50
Fat	3.88	2.75	2.35	3.28	2.03
N. free extract	49.19	50.78	49.50	57.55	55.80
Crude fiber	21.45	20.48	25.75	21.25	22.13
N. × 6.25	13.13	14.19	4.75	7.52	7.69
Ash	8.07	7.93	13.53	5.34	6.90
Fat	4.07	2.87	2.47	3.47	2.16
N. free extract	51.59	53.01	51.97	60.80	59.27
Crude fiber	22.50	21.38	27.04	22.45	23.50
N. × 6.25	13.77	14.81	4.99	7.94	8.17
Total nitrogen	2.20	2.37	.80	1.27	1.31
Non-albuminoid nitrogen	.77	.58	.09	.32	.38
Per cent. of N. non-albuminoid	35.0	24.6	11.2	25.2	29.0
Nutritive ratio	4.0	3.8	10.9	8.1	7.5

	S. L. GOODALE, SACO, ME.			
	No. 132.—Vicia sativa	No. 124.—Dactylis glomerata.	No. 136.—Triticum repens.	No. 125.—Paspalum ovatum.
Development	Full bloom	Full bloom	Full bloom	Full bloom
When cut	....	....	....	....
Height in centimeters	....	....	....	....
Water in fresh grass	....	....	....	....
Water	6.10	5.85	6.00	5.75
Ash	5.80	7.55	6.85	8.00
Fat	4.38	2.25	3.60	2.08
N. free extract	44.39	51.59	47.89	55.06
Crude fiber	19.03	24.53	23.78	23.33
N. × 6.25	20.30	8.23	11.88	5.78
Ash	6.18	8.02	7.28	8.49
Fat	4.66	2.39	3.83	2.21
N. free extract	47.27	54.80	50.95	58.42
Crude fiber	20.27	26.05	25.30	24.75
N. × 6.25	21.62	8.74	12.64	6.13
Total nitrogen	3.46	1.40	2.02	.98
Non-albuminoid nitrogen	1.01	.36	.60	.26
Per cent. of N. non-albuminoid	29.2	25.7	29.7	26.5
Nutritive ratio	2.4	6.5	4.3	10.0

Analyses of grasses—Continued.

	W. H. CHEEK, WARREN COUNTY, NORTH CAROLINA.		DR. W. C. BENBOW, GREENSBORO', N. C.		C. G. PRINGLE, HAZEN'S NOTCH, VT.
	No. 56.—Dactylis glomerata.	No. 57.—Poa pratensis.	No. 58.—Dactylis glomerata.	No. 59.—Arrhenatherum avenaceum.	No. 110.—Milium effusum.
Development	Full bloom	Before bloom	Early bloom.	Late bloom (?)	....
When cut	May 16	June 16	May 12	May 12	....
Height in centimeters	....	....	....	....	....
Water in fresh grass	....	....	....	....	....
Water	6.40	7.30	6.37	7.45	5.70
Ash	6.95	8.35	8.33	7.80	8.75
Fat	3.33	4.03	3.45	2.60	3.65
N. free extract	52.44	44.45	48.84	46.25	43.70
Crude fiber	21.60	22.37	23.38	24.15	23.15
N. × 6.25	9.28	13.50	9.63	*11.75	15.05
Ash	7.42	9.01	8.90	8.43	9.28
Fat	3.56	4.35	3.68	2.81	3.87
N. free extract	56.03	47.95	52.16	49.97	46.33
Crude fiber	23.08	24.13	24.97	29.09	24.55
N. × 6.25	9.91	14.56	10.29	12.70	15.97
Total nitrogen	1.58	2.33	1.61	2.12	2.64
Non-albuminoid nitrogen	.30	.45	.63	†1.09	.76
Per cent. of N. non-albuminoid	19.0	19.3	30.1	‡51.4	28.8
Nutritive ratio	6.0	3.6	5.4	4.2	3.1

	DEPARTMENT GROUNDS.			J. J. ROSA, MILFORD, DEL.	
	No. 106.—Triticum repens.	No. 74.—Festuca pratensis.	No. 99.—Panicum sanguinale.	No. 131.—Poa compressa.	No. 137.—Agrostis vulgaris.
Development	Early bloom.	After bloom.	Before bloom	In bloom ...	....
When cut	June 23	June 1	June 23	June 6	....
Height in centimeters	60	76	52	....	....
Water in fresh grass	58.3	....	76.5	....	....
Water	4.80	7.60	5.40	5.20	6.65
Ash	8.35	6.62	*14.20	6.20	6.10
Fat	3.20	3.05	4.58	4.03	3.30
N. free extract	56.52	46.70	35.94	52.72	53.02
Crude fiber	18.75	25.53	18.00	19.10	20.43
N. × 6.25	8.35	10.50	†21.88	12.75	10.50
Ash	8.77	7.16	....	6.54	6.53
Fat	3.36	3.30	....	4.25	3.54
N. free extract	59.37	50.54	....	55.61	56.80
Crude fiber	19.70	27.63	....	20.15	21.88
N. × 6.25	8.80	11.37	....	13.45	11.25
Total nitrogen	1.41	1.82	....	2.15	1.80
Non-albuminoid nitrogen	.26	.79	....	.53	.45
Per cent. of N. non-albuminoid	18.7	43.5	....	24.5	25.0
Nutritive ratio	7.1	4.7	....	4.5	5.4

*Duplicate, 12.25. †1.09. ‡51.4. *Duplicate, 14.25. †21.70.

HOW THE NITROGEN IS COMBINED IN THE PLANT.

As an example of the forms in which the nitrogen occurs, a study of *Dactylis glomerata* (orchard grass) will serve. In its young state, a large amount of the total nitrogen exists in the form of compounds of a non-albuminoid nature. What these are must be deduced from the following determinations:

"Total nitrogen" (by soda lime)	2.40	2.38
N. soluble in water	.98	....
Soluble in 80 per cent. alcohol	.98	....
N. soluble in water and not precipitated by—		
tannic acid	.98	....
phosphotungstic acid	1.01	1.01
cupric hydrate	.84	.87
phosphomolybdic acid	.84	....
basic lead acetate	.84	.70
N. soluble in water and lactic acid and not precipitated by cupric hydrate	.73	.70
Nitric acid containing N.	.099	....
Ammonia containing N.	.093	....
Nitrogen as amides of amido acids	none	....
Nitrogen as amido acids	?	....
Nitrogen in carbamide forms	traces	....

The nitrogenous substances which might possibly exist in the plant under examination are ammonia salts, nitrates, alkaloids, peptones, carbamide bodies, amides of amido acids, amido acids, and albuminoids. Of these, direct determinations have shown the presence of ammonia and nitrates. The nitrogen of the latter is, however, not included in the "total nitrogen," as that was found by combustion with soda-lime. We can conclude, from the fact that tannic acid and phosphotungstic acid precipitate no nitrogen in water solution, that there are probably no alkaloids or peptones present. Amido acids probably constitute the larger portion of the non-albuminoid nitrogen, for there is a lively evolution of nitrogen on treating the aqueous extract with nitrous acid. Amides, such as asparagin, are absent, for on boiling with acid and subsequent treatment with magnesia no more ammonia is evolved than by the original aqueous extract.

The alcoholic or water extracts of the grass on concentration evolve with hypobromite a small amount of nitrogen, which, however, may be formed by decomposition of the amido acids; in fact this is the case when the juice of the freshly-cut grass is evaporated several times. It forms a sirupy liquid smelling like meat extract and evolving torrents of nitrogen with hypobromite.

From the small amount of nitrogen which is found to occur in other forms, we must conclude it to be present principally as one or more amido acids, and the determination by the method of Stützer by precipitating all other forms with cupric hydrate in a lactic-acid extract shows that they contain nitrogen amounting to 34.2 per cent. of the whole.

What the substances are which cause the varying amounts of nitrogen in the precipitates by the several reagents, and amounting to .11–.17 per cent., cannot be said. At one time basic lead acetate would precipitate the larger amount and at another the smaller, probably owing to some change in condition.

In order if possible to isolate the amido acids, an examination has been made of the juice expressed from 30 pounds of Dactylis cut before the panicle began to appear. After precipitation of the color, organic acids, &c., with lead subacetate, the filtrate, after removal of the latter with hydrogen sulphide, was concentrated to a sirup, but the acetic acid

present brought about the decomposition of the amido substances, so that although they could be still detected they were so adulterated with carbamide bodies that no practical method of separation could be found. Strong alcohol brought about only a precipitate of sulphate, chloride, and nitrate of potash, which were separated by crystallization. All attempts to obtain an organic substance in definite form were failures. This shows the presence of some unstable amido compound, which breaks up into carbamide bodies. It will probably be possible to ex tract it by more careful treatment to avoid decomposition.

THE EEFECT OF LOCALITY AND SOIL ON THE COMPOSITION OF GRASSES

To illustrate this point, the analyses which we have made of orchard grass from various parts of the country are collected and tabulated.

Analyses of Dactylis glomerata (orchard grass) from various localities.

EARLY BLOOM.

Ash.	Fat.	N. free extract.	Crude fiber.	Nitro. × 6.25.	Total nitrogen.	Non alb. nitrogen.	% of Tot. N. as Non alb.	Locality.
8.64	3.98	50.20	24.67	12.51	1.99	.77	38.7	District of Columbia.
8.90	3.68	52.16	24.97	10.29	1.61	.63	39.1	North Carolina.

FULL BLOOM.

Ash.	Fat.	N. free extract.	Crude fiber.	Nitro. × 6.25.	Total nitrogen.	Non alb. nitrogen.	% of Tot. N. as Non alb.	Locality.
7.42	3.56	56.03	23.08	9.91	1.58	.30	19.0	North Carolina.
8.07	3.24	53.76	25.40	9.53	1.53	.16	10.5	District of Columbia.
8.02	3.39	54.80	26.05	8.74	1.40	.36	25.7	Maine.
6.00	3.62	57.34	24.42	8.62	1.38	.42	30.4	District of Columbia.
6.33	2.66	54.94	27.51	8.56	1.37	.51	37.2	Pennsylvania.
8.44	3.49	54.75	24.91	8.41	1.35	.42	30.9	New Hampshire.

	Ash.	Fat.	N. free extract.	Crude fiber.	Nitro. × 6.25.	Total nitrogen.	Non alb. nitrogen.	% of Tot. N. as Non alb.
Average early bloom	8.77	3.83	51.18	24.82	11.40	1.80	.70	39.9
Average full bloom	7.38	3.33	55.17	25.19	8.91	1.43	.36	25.2

It will be seen that the amount of amides varies greatly for the same period of development, but it is to be remembered that one or two days will cause a great change in this respect without corresponding apparent change to the eye in the development of the plant, so that the period known as that of full bloom, which may extend over several days, may include, and probably does, greater changes in the internal structure of the grass than are visible to the eye in its outward aspect.

The averages for "early" and "full bloom" show the changes which might be expected from the conclusions drawn on preceding pages.

ANALYSES OF FEED STUFFS, &c.

At the request of J. W. Sanborn, director of the New Hampshire State Farm at Hanover, the following analyses were made:

206. Cotton-seed meal;
207. Wheat bran;
208. Yellow corn;
209. Linseed meal (expressed);

210. Early half long carrot;
211. Corn-fodder (moist and mouldy).

Book No.	Condition.	Water.	Ash.	Fat.	N. free extr.	Crude fiber.	Nitrogen cal. as albumen.	Total nitrogen.	Non-alb. nitrogen.	Per cent. of total N. as non-album.	Nutritive ratio.
206	Air-dry	8.10	7.95	13.95	20.12	6.48	43.40				1:10
207	....do	8.65	6.15	5.60	57.43	5.90	16.27	2.60	.42	16.2	1:39
208	....do	11.80	1.80	6.15	66.32	1.85	12.08				1:6
209	....do	9.35	5.90	2.65	37.42	7.58	37.10				1:1.1
210	Fresh	88.82	.93	.65	7.39	.86	1.35	.216	.175		
210	Dry		8.33	5.83	66.10	7.69	12.05	1.93	1.47	76.1	1:6
211	Moist	16.23	6.43	1.58	48.20	23.27	4.29	.68	.08		
211	Dry		7.68	1.89	57.54	27.78	5.11	.821	.097	11.8	1:11.6

ANALYSES OF DISTILLERY WASTE.

No. 212. Total solids allowed to separate from slop, and dried.

No. 214. Solids collected after drawing off supernatant liquor before it has completely settled.

No. 215. Sediment from liquid drawn from No. 214. Fine, moist, and paste-like.

Book No.	Condition.	Water.	Ash.	Fat.	N. free extr.	Crude fiber.	N. × 6.25 album.	Nutritive ratio.
212	Air-dry	5.00	11.25	12.32	36.08	8.00	27.35	
	Dry		11.84	12.97	37.98	8.42	28.79	1:8
214	Air-dry	6.20	8.50	6.35	45.90	3.65	29.40	
	Dry		9.06	6.77	48.94	3.89	31.34	1:8
215	Moist	87.00	1.32	1.50	5.73	.08	4.37	
	Dry		10.12	11.54	44.10	.65	33.59	1:7

ANALYSIS OF GLUCOSE WASTE.

No. 213. The waste from the glucose factories, after separation of the starch:

	As received.	Dry.
Water	76.00	......
Ash	.51	2.13
Fat	1.63	6.77
N. free extract	17.39	72.46
Crude fiber	.75	3.13
N. × 6.25	3.72	15.51
	100.00	100.00

ANALYSIS OF RICE BRAN.*

No. 216. Rice bran from N. H. Sewell, Simmsport, Ga.:

Water	9.30
Ash	8.35
Fat	5.23
N. free extract	62.34
Crude fiber	2.00
N. × 6.25	12.78
	100.00

* See analysis of rice waste, Report Department of Agriculture, 1879, p. 102.

THE COMPOSITION AND QUALITY OF CERTAIN AMERICAN WINES.

The annual production of American wines has reached such proportions that it has been deemed advisable to begin, at least, a careful chemical examination of the more prominent brands, both for the security of consumers and the information of manufacturers.

As wine is a liquid of very complex composition, and as certain foreign wines can be sold in this country at very low prices, there is great danger that the illegitimate arts of the professional "improver" will, in great measure, nullify the results attained by the more honorable winemaker. In fact, the investigations thus far made conclusively show that the ability to "doctor" and falsify wines is not lacking in this country. Just here it should, in justice, be stated that the substances most frequently added to wines are not the gross poisons popularly supposed to be used, but rather alcohol, molasses, glucose made from starch, and occasionally some foreign vegetable coloring matters, such as elder berries; and these practices are in reality abetted by the lack of knowledge and the depraved taste of the public which demands strongly alcoholic or very sweet wines.

It can be safely stated, on the authority of the best chemists who have made wine analysis a study, that true wines are not strongly alcoholic, and usually they are not decidedly sweet.

An examination of the analyses in Tables I, II, IV will show that most dry red or white wines do not contain more than 10 per cent. (by weight, equal to about 12 per cent. by volume) of alcohol; some cases occur where slightly more than 12 per cent., by weight, of alcohol is present, but while it is possible that such wines might be made by fermentation of very sweet grapes, the chances are that 2 or 3 per cent. of alcohol have been added in order to keep wine which would be otherwise instable from bad handling.

As to ports, sherries, and similar strong wines, it is well known that they are all more or less "fortified" by addition of common alcohol, deodorized alcohol ("cologne spirits"), or brandy, and the same may be said of the greater number of sweet wines. The use of such wines in medicine should be discouraged, for the reason that there is no security, in buying them, that one will find two samples at all alike either in alcoholic strength, sweetness, astringency, or body. Again, all such wines have a tendency to encourage the use of such strong liquors as brandy or whisky, rather than the less harmful light wines. Dry or moderately sweet red or white wines are chemically and medicinally better in nearly every case; they can be furnished at reasonable rates, and experience shows that the danger of forming intemperate habits from their use is very much less than where the stronger wines are prescribed.

The very best wines are made from the grape juice ("must") only; white wines can be made from the juice of red or white grapes, provided only the skins are not allowed to remain in the fermenting vats. Red or dark colored wines are produced, normally, by fermenting the juice in presence of the skins of dark colored grapes; the grape color is not soluble in pure water, but becomes soluble in the wine through the action of the alcohol and acids present in the forming wine. The use of any foreign colors whatsoever is very objectionable, and should be discouraged by all wine makers.

Wines made by simple fermentation of the grape juice are not likely to contain any sugar, and are called "dry" wines; if white, they have many names, usually derived from the kinds of grapes used, the locality where grown, or some real or fancied resemblance to the finer brands of

foreign wines. If they are red they are often called clarets; these are dry red wines of rose-red or darker color, moderately acid and astringent, and of an alcoholic strength of 8 to 11 per cent. by weight. Burgundy wines are usually darker colored and more astringent. There are many slight differences in odor or taste which serve to distinguish the wines from different grapes, and it is often found to be advantageous to use several kinds of grapes for one wine.

Even wines ostensibly from the same variety of grape differ greatly in taste when received from different makers, and all the wines of certain vineyards have some peculiar after-taste pleasant or otherwise, which serves to distinguish them from all others.

Ripe or over-ripe grapes, if not mildewed, make the strongest, best-flavored, and best-keeping wines. Grapes not fully ripened are more acid and contain less sugar; hence they produce weak, sour wines, which are too frequently "improved" by additions of spirit, in order to make them more salable and less likely to spoil.

The temperature at which fermentation is carried on has much to do with the quality of the wine. If the cellar is rather warm the fermentation is rapid, the growing yeast-cells are thrown to the top of the liquid ("top yeast"), and the wine produced is inferior in quality. If the fermentation goes on at a lower temperature, the yeast-cells sink ("bottom yeast"), more time is required, but the wine is of better quality.

Free exposure to the air after this first fermentation is undesirable, as it tends to increase the acidity of the wine, the oxygen of the air changing more or less of the alchohol to acetic acid, the characteristic acid of vinegar. Besides this there is considerable danger that certain diseases, at present not thoroughly understood, will set in and spoil the wine. For these reasons but slight access of air is allowed. Most wines go through a slow second fermentation in the barrel. After this is completed they can be kept in tight tasks, or, better, in bottles laid on their sides or placed in racks, cork down, in cool cellars.

Sparkling or "champagne" wines are properly made by fermentation in nearly full, corked bottles. As during fermentation it is practically (at least approximately) true that two parts of sugar furnish one part each of alchohol and carbonic acid gas, it will be seen that a very considerable amount of gas is contained, under pressure, in each bottle. Upon pouring the wine out and exposing it freely to the air it parts with the greater portion of this gas and is correspondingly less brisk, but it still contains more dissolved gas than could be retained by water under the same circumstances, owing to the greater solubility of carbonic acid gas in alchohol than in water.

That certain cheaper grades of native champagnes are artificially charged with gas seems quite probable, but this is a statement very hard to prove by positive chemical evidence. And further, it is doubtful whether such artificially-charged wines would be any better or worse than those made by the regular process, *provided* the wine used as a basis were as good as that remaining after expelling the gas from a true champagne. In absence of carefully-recorded experiments, and in view of the fact that no manufacturer will own that he uses any other than the regular methods, this is a question still to be answered. This much is true, however, that he who sells an artificially-charged champagne as one made by the regular method is guilty of falsehood, and would not be likely to be over-scrupulous as to the quality of the wine he used, provided only that it were salable. To sell these "gas wines" as such is the only honorable method.

Let us now consider the question as to the value of wine analyses.

In the first place, the analysis of any wine, however complete it may be, can show only certain qualities or peculiarities of the sample, and must always leave untouched many questions relating to the more delicate shades and differences in quality which have very much to do with the value of the wine. The mere examination of the analysis of any wine cannot show whether that wine has a pleasant or a disagreeable odor or taste, but within certain limits it can show whether the constituents estimated are in proper quantities. Rightly interpreted also, these figures go far to show the character and skill of the maker, and although the analyst may not always feel that he has sufficient evidence to prove fraud or deception, still he is frequently convinced thereof. In certain cases there can be no doubt of sophistication, in others the additions have been so slight and so carefully made as to render it very difficult to prove them.

The composition of wines normally made from various kinds of grapes is pretty well known in European countries, and any great deviations from the there accepted standards is considered due to falsification, for which appropriate penalties are imposed; but a large and comprehensive series of analyses of American wines from all sources seems not yet to have been made. The analyses here appended have had for their chief object the settlement of the question as to the composition of the best American wines as furnished for analysis by the manufacturers, and secondly, the composition of the American wines actually furnished to consumers.

Circular letters were sent to a number of the more prominent manufacturers and dealers in American wines asking for samples of their various brands, and in nearly every case the goods were promptly shipped. It is fair to suppose that the wines so obtained represent the best American product in most cases, and it may here be remarked that the dry white and red wines were in many cases of very fine quality, and gave evidence of skill in manufacture and handling.

Besides these wines a considerable number were purchased of responsible retail dealers in the city of Washington. In nearly every case the samples were in original bottles with the label affixed of the manufacturer; a few were drawn from the cask, and a very fewwere of unknown origin. In some cases the wines so obtained were equal in quality to those obtained from the manufacturers; in certain other cases the purchased wines had the same general character, but were more acid and less alcoholic, showing the use of less carefully selected grapes. Probably the care taken of many of these wines was not always such as it should be. Often, also, it was impossible to ascertain the vintage year for certain samples. In a general way it may be said that the dry wines were frequently quite good, and in certain cases fully equal in quality to those obtained from the manufacturers. The so-called American ports and sherries are not to be commended, for many of them seem to have been made by bunglers whose sole object seems to have been to use the cheapest sugar or molasses and the poorest and cheapest form of alcohol, brandy, or whisky. Some exceptions there are, but the best articles have not the characteristic taste, color, odor, &c., of good sherry or port.

An examination of the analyses of the various sweet wines will reveal the great differences in their composition. Surely a wine containing from one-sixth to one-fourth its weight of sugar alone is not one to be commended on the score of healthfulness; if at the same time the wine is strongly alcoholic, the evil is increased, for it should be remembered that of two wines (a dry and a sweet) showing the same percentage by weight of alcohol, the heavy wine contains *in the same volume* frequently considerably more real alcohol than does the lighter dry wine.

In comparing such wines, the best judgment as to their relative alcoholic strength may be formed from an inspection of the column showing "Per cent. of alcohol by volume," for the reason that consumers of wines always think of the amount of alcohol in a given volume. Thus judged, it appears that many sweet wines have nearly or quite twice the alcoholic strength of natural dry wines. (Compare Tables I, II with III.) This greater alcoholic content can only be obtained by the addition of alcohol in some form. It will be for the best health of consumers to use natural dry wines, or wines only moderately sweetened and moderately alcoholic.

So soon as the professional "improver" is allowed to use his peculiar methods and formulæ there is no longer any safety. A law regulating these matters, if carefully framed and honestly administered, would in time be found to promote the interests of legitimate wine makers. It is to be hoped that the demand for true wines may tend to crowd out these products of the "improver"; it is certain that many wine makers are forced against their inclination, by the demand, to make these wines, although they would prefer to sell a more natural article.

Of the champagnes it may be said that, on the whole, their quality was surprisingly good. Two or three samples were either unwarrantably sweet or had some slightly unpleasant taste.

As a general thing the quality of champagnes is better the less sugar they contain, but their palatability does not depend on this alone. The amount of gas, acidity, and peculiar flavors derived from the grape have much to do in determining the value. Several brands here enumerated (Table III) would compare very favorably with imported champagnes of good reputation.

The very sweet brands are quite likely to cause headaches, well known to many as the after effects of the too free use of any sweet wines.

Very great differences in "body" were noticed; by this term "body" is understood a certain full, nourishing taste suggestive of considerable dissolved matters, but very hard to describe accurately. A wine lacking this "body" cannot be considered really good, even though it may have otherwise a pleasant flavor and odor. For this, as for numerous other qualities of wines, chemical tests are unsatisfactory and liable to be misleading; the judgment of an impartial and practiced wine taster is of first value.

The reader is referred to the following list of parties furnishing wines, and to the first eight tables next appended, for the composition of the individual samples. Table IV shows the averages drawn from the analyses of dry, red, and white wines (see Tables I and II) as well as the highest and lowest percentages observed. These latter extreme figures are merely useful as showing the observed limits of variation, but they frequently show the wine in which they were determined to have been abnormal, or at least exceptional, in one or more particulars.

It is obvious that to extend these figures to ports, sherries, and miscellaneous wines (Table III) would be of no value, for the variations are so great as to render averages drawn from such figures very misleading. And it should also be remembered that the average figures given in Table IV should not be construed as casting credit or discredit upon those particular samples which may chance to differ from them more or less. These averages merely show the following facts, viz:

Dry red American wines have, as a general thing, a higher specific gravity, more total residue and ash, and are slightly more acid and less alcoholic than dry white wines of American manufacture; further, there is less variation, in most particulars, between the highest and lowest results obtained in analysis of dry red wines.

It must be admitted that the total acidity, as well as the considerable amount of acetic acid contained in many American wines, is rather too high; it results from the use of grapes not fully ripened and not carefully selected, from too rapid fermentation in warm cellars, and from too great exposure to the air of the nearly or quite finished wines (causing partial acetification). The German wine makers aim to produce wines whose total acidity (stated as tartaric acid) shall not exceed 0.6 per cent., and with few exceptions they succeed. This is a matter worthy the careful attention of American wine makers.

Sharp competition in prices has led to the addition of sugar and water to the must in many cases in order to increase the amount of wine produced and lessen the cost. Although this is done in all countries, it is still to be regretted, for while quite palatable wines may be produced, they lack that full body and flavor only to be had by fermenting the juice of the grape without additions. That there are certain bad years when grapes are so acid and deficient in sugar as to render the addition of a moderate amount of the latter necessary is not to be denied, but in ordinary or good years no additions are required. The wines thus normally produced would cost more in some cases, but they would be far superior in quality and worth the increased price. The judicious selection of varieties, and often the use of one kind of grape known to be prolific in conjunction with some other variety, of more desirable flavor, but giving a smaller yield of grapes, will often insure both a large yield and a superior quality of wine. Many wines which have been made from sweetened and diluted must are found deficient in fixed acid, while they contain an excessive amount of volatile acid.

It has been the aim to show by these analyses the actual composition of American wines, and a careful study of the analytical figures, in the light of what has been here written, will serve to give a fair idea as to the general quality of such wines at the present day. It may briefly be stated that a very considerable number of vineyards, in nearly every section of the country, produce fair to good dry wines; some makers furnish very good champagnes; a few fair very sweet wines have been examined. It is not thought best to here compare the wines of one manufacturer with those of another, for failure to produce fine wines seems often to have been due more to inexperience than to intentional adulteration.

The work already accomplished should be only preliminary to the careful study of the whole question of American wine-making. One or two competent chemists could be continuously engaged for years in making careful examinations of grapes, must, and wines, not only such as have been here recorded, but in the investigation of the effects of different methods of treatment in the various stages of fermentation and "ageing," the examination of those constituents existing in all wines in small amounts (glycerine, succinic acid, tannin, color, "bouquet," albumen, phosphoric acid in the ash, &c.), and in fact the elucidation of numberless vexed questions. It is to be hoped that means may be afforded this department for the more elaborate and thorough study of this important industry.

LIST OF WINES ANALYZED.

No.	Name.	Places obtained.
1	White Hoe Wine	Washington, D. C.
2	Sherry	Tharp & Co., 820 F street, northwest, Washington, D. C.
3	Virginia Claret	E. Abner, 413 Ninth street, northwest, Washington, D. C.
4	Zinfandell, California	Do.
5	Missouri	Do.
6	Riesling, California	Do.
7	Ohio Catawba, Lenk Wine Co	Do.
8	California Hock	Do.
9	California Dry Muscatel	Do.
10	Sunny Slope Port, Perkins, Stern & Co	Hume, Cleary & Co., 807 Market Space, Washington, D. C.
11	Concord Bouquet, Vineland Wine Co	Do.
12	Red Wine, Vineland Wine Co	Do.
13	California Sonoma Hock	Do.
14	Dry Sillery Champagne	Do.
15	Black Rose	Charles Saalmann, Egg Harbor City, N. J.
16	Virginia Claret, '79	Monticello Wine Company, Charlottesville, Va.
17	Virginia Clinton, '79	Do.
18	Cynthiana, '80	Do.
19	Alvey, '80	Do.
20	Norton's Virginia, '79	Do.
21	Virginia Hock, '79	Do.
22	Ives' Seedling, '79	Do.
23	Pure Grape Brandy, '78	Do.
24	"Great Western" Extra Dry Champagne, Pleasant Valley W. Co.	G. G. Cornwell, 1418 Pennsylvania avenue, Washington, D. C.
25	Grand Prize Medium Dry Champagne, Arpad Haraszthy.	Do.
26	"Eclipse" Extra Dry Champagne, Arpad Haraszthy.	Do.
27	Gold Seal Champagne, Urbana Wine Co	Do.
28	Port, White Elk Vin., Iowa	Do.
29	White Concord, '75, White Elk Vin., Iowa	Do.
30	Sweet Catawba, '71, White Elk Vin., Iowa	Do.
31	Concord, '73, White Elk Vin., Iowa	Do.
32	Norton's Virginia, '75, White Elk Vin., Iowa	Do.
33	Clinton, '72, White Elk Vin., Iowa	Do.
34	St. Julien, White Elk Vin., Iowa	Do.
35	La Rose, White Elk Vin., Iowa	Do.
36	Claret, '74, White Elk Vin., Iowa	Do.
37	Zinfandell	Do.
38	California Claret	Do.
39	California Sherry	Do.
40	American Port, Pleasant Valley W. Co	Do.
41	California Port	Do.
42	California Angelica	Do.
43	California Malaga, Henry Gerke	Do.
44	Sweet Catawba, Pleasant Valley W. Co	Do.
45	Dry Catawba, Pleasant Valley W. Co	Do.
46	Brocton Port, G. E. Ryckman	Do.
47	Brocton Sweet Catawba, G. E. Ryckman	Do.
48	Brocton Dry Catawba, G. E. Ryckman	Do.
49	Brocton Sweet Regina, G. E. Ryckman	Do
50	California Riesling Hock	Do.
51	Gerke White Wine, Henry Gerke	Do.
52	California Port, Kohler & Frohling	B. W. Reed's Sons, 1216 F street, northwest, Washington, D. C.
53	Sherry, Perkins, Stern & Co	Geo. E. Kennedy & Son, 1209 F street, northwest, Washington, D. C.
54	California Muscatel, Perkins, Stern & Co	Do.
55	Sans Pareil Champagne, Wm. H. Mills	N. W. Burchell, 1332 F street, northwest, Washington, D. C.
56	"Old Dominion" Claret, C. A. Heineken	Do.
57	Speer's Port, Alfred Speer	Do.
58	Speer's California Sherry, Alfred Speer	Do.
59	Concord, '80	Chr. Xander, 911 Seventh street, northwest, Washington, D. C.
60	Clinton, '80	Do.
61	Ives, '80	Do.
62	Norton's Virginia Seedling, '80	Do.
63	Ives and Clinton, '80	Do.
64	Ives and Clinton, '79	Do.
65	Concord and Clinton, '79	Do.
66	Zinfandell, '78, Dresel & Co	Do.
67	Zinfandell, '79, Dresel & Co	Do.
68	California Hock, Dresel & Co	Do.
69	California Sherry, Dreyfus & Co	Do.
70	California Port, Dreyfus & Co	Do.
71	California Muscatel, Dreyfus & Co	Do.
72	Dry Catawba, Kelly Island	Do.
73	Sweet Catawba, Bass Island	Do.

LIST OF WINES ANALYZED—Continued.

No.	Name.	Place obtained.
74	Ruby Claret, '75	J. H. Bannihr, Egg Harbor City, N. J.
75	Ruby Claret, '76	Do.
76	Ruby Claret, '77	Do.
77	Ruby Claret, '78	Do.
78	Ruby Claret, '79	Do.
79	Ruby Claret, '80	Do.
80	Clevener, '76	Do.
81	Cynthiana, '76	Do.
82	Franklin, '76	Do.
83	Norton's Virginia, '77	Do.
84	Franklin, '68	Julius Hincke, Egg Harbor City, N. J.
85	Jersica, '68	Do.
86	Catawba, '68	Do.
87	Iolhink, 68	Do.
88	"Imperial" Champagne	Isaac Cook's American Wine Company, Saint Louis, Mo.
89	Concord	Do.
90	Virginia Seedling	Do.
91	"Fine Claret"	Do.
92	Burgundy	Do.
93	Missouri Catawba	Do.
94	Norton's Virginia Claret, '80	W. J. Green, Fayetteville, N. C.
95	Sweet Delaware, '79	Do.
96	Sweet Concord, '80	Do.
97	Dry Concord	Do.
98	"Scuppernong," '80	Do.
99	"Scuppernong" Sweet, '78	Do.
100	"Scuppernong" Dry	Do.
101	"Imperial" Champagne, Isaac Cook	Jno. H. Magruder, 1421 New York avenue, northwest, Washington, D. C.
102	"Red Cross" Champagne, M. Werk & Son	Do.
103	California Port, Perkins, Stern & Co	Do.
104	California Angelica, Perkins, Stern & Co	Do.
105	"Marsala", Perkins, Stern & Co.	Do.
106	Dry Muscat	B. Dreyfus & Co., 45 Broadway, N. Y.
107	White Zinfandell	Do.
108	Riesling	Do.
109	Gutedel	Do.
110	Hock	Do.
111	Port	Do.
112	Grape Brandy	Do.
113	Sherry	Do.
114	Claret, Mission	Do.
115	Red Zinfandell	Do.
116	Angelica	Do.
117	Sweet Muscat	Do.
118	"A. A" Catawba, second quality	Wherle, Werk & Co., Middle Bass Island, Ohio.
119	"A. A. A" Catawba, first quality	Do.
120	I. & N.	Do.
121	Norton	Do.
122	Ives	Do.
123	Delaware	Do.
124	Concord	Do.
125	Mount Vernon	C. A. Heineken, Haymarket, Prince William County, Virginia.
126	"Old Dominion" Claret	Do.
127	Prince William	Do.
128	Native Wine, '77	L. & H. Huning, Los Lunas, N. Mex.
129	Port	Pleasant Valley Wine Company, Reims, N. Y.
130	Dry Catawba	Do.
131	Sweet Catawba	Do.
132	Great Western Champagne	Do.
133	Concord, '73	White Elk Vineyards, Keokuk, Iowa.
134	White Concord, '75	Do.
135	Norton's Virginia, '75	Do.
136	Ives, '74	Do.
137	Clinton, '72	Do.
138	Sonoma Mission, '78	Gretsch & Mayer, 96 and 98 Fulton street, N. Y
139	Sonoma Red Mission, '79	Do.
140	Sonoma Riesling, '77	Do.
141	Sonoma Reisling, '79	Do.
142	Sonoma Mission, '79	Do.
143	Sonoma Gutedel, '79	Do.
144	Dry Muscat, '74	Do.
145	Sonoma White Zinfandell, '78	Do.
146	Sonoma White Zinfandell, '79	Do.
147	Sonoma Red Zinfandell, '79	Do.
148	Ohio Catawba, '79	Do.
149	Ohio Catawba, '80	Do.
150	Helena, ? '79	Do.
151	Los Angeles Muscat	Do.
152	Los Angeles Angelica	Do.

LIST OF WINES ANALYZED—Continued.

No.	Name.	Place obtained.
153	Los Angeles Port	Gretsch & Mayer, 96 and 98 Fulton street, N. Y.
154	Virginia Concord, '79	Do.
155	Ives' Seedling, '80	Poeschel, Scherer & Co., Hermann, Gasconade County, Missouri.
156	Riesling, '80	Do.
157	Cynthiana, '80	Do.
158	Clinton, '80	Do.
159	Ruländer, '80	Do.
160	Virginia Seedling, '80	Do.
161	Delaware, '80	Do.
162	Concord, '80	Do.
163	Herbemont, '80	Do.
164	Catawba, '80	Do.
165	Taylor, '80	Do.
166	Goethe, '80	Do.
167	Sans Pareil Champagne	Wm. H. Mills, Sandusky, Ohio.
168	Le Diamant Champagne	Do.
169	Norton's Virginia, '72 Champagne	Do.
170	Brandy, '76	H. T. Dewey & Son, 138 Fulton, street, N. Y.
171	Norton's Seedling, '78	Do.
172	Concord & Norton's, '78	Do.
173	Catawba, '79	Do.
174	Catawba Champagne, '78	Do.
175	Iona & Catawba, '71	Do.
176	Iona, '70	Do.
177	Delaware, '75	Do.
178	Catawba	Fritz Baier, Greenfield, Nelson County, Virginia.
179	White Concord	Do.
180	Red Concord	Do.
181	Clinton	Do.
182	Norton's	Do.
183	"Red Cross" Champagne, M. Werk & Son	Jno. H. Magruder, 1421 New York avenue, northwest, Washington, D. C.
184	Sweet Catawba, Pleasant Valley W. Co	Do.

ANALYSES OF AMERICAN WINES.

I.—Dry Red Wines.

No.	Name.	Specific gravity.	Per cent. alcohol, by weight.	Per cent. alcohol, by volume.	Per cent. total residue.	Per cent. total ash.	Per cent. glucose.	Per cent. total acid, as tartaric.	Per cent. fixed acid, as tartaric.	Per cent. volatile, acid as acetic.	Maker.
3	Virginia Claret	.9941	9.61	12.05	2.03	0.193	0.13	0.725	0.393	0.266	Monticello Wine Company.
16	Virginia Claret, Concord, '79	.9953	8.83	11.08	2.10	.174	Trace	.709	.452	.206	Do.
17	Virginia Clinton, '79	.9950	9.82	12.31	2.36	.238	None	.784	.513	.217	Do.
18	Cynthiana, '80	.9969	10.24	12.87	2.95	.283	.09	.647	.376	.217	Do.
19	Alvey, '80	.9931	9.77	12.22	2.13	.174	Trace	.680	.498	.146	Do.
20	Norton's Virginia, '79	.9937	10.21	12.77	2.88	.298	do	.772	.377	.316	Do.
22	Ives' Seedling, '79	.9944	8.68	10.82	2.18	.247	do	.723	.512	.169	Do.
32	Norton's Virginia, '75	.9996	6.36	8.01	2.62	.275	do	.825	.381	.355	White Elk Vineyards.
135	Norton's Virginia, '75	.9983	8.26	10.38	2.95	.295	do	.762	.481	.385	Do.
31	Concord, '73	1.0011	5.75	7.25	2.80	.273	do	.704	.395	.247	Do.
133	Concord, '73	.9970	7.65	9.62	2.53	.359	None	.722	.316	.325	Do.
33	Clinton, '72	.9982	5.71	7.17	2.07	.192	Trace	.902	.292	.488	Do.
137	Clinton, '72	.9961	7.93	9.95	2.19	.196	None	.798	.391	.326	Do.
34	St. Julien	.9959	7.14	8.96	1.99	.210	do	.587	.247	.272	Do.
35	La Rose	.9987	7.91	9.95	2.61	.268	do	.766	.400	.293	Do.
36	Claret, '74	.9988	9.02	11.35	2.69	.236	do	.826	.411	.332	Do.
59	Concord, '80	.9933	8.72	10.91	2.38	.185	.45	.619	.332	.230	C. Xander.
60	Clinton, '80	.9920	10.90	13.62	2.49	.165	.30	.620	.302	.254	Do.
61	Ives, '80	.9925	8.65	10.82	2.17	.152	.20	.680	.363	.254	Do.
62	Norton's Virginia, '80	.9941	8.99	11.26	2.38	.222	.12	.662	.308	.283	Do.
63	Ives and Clinton, '80	.9920	9.62	12.05	2.17	.183	Trace	.635	.372	.210	Do.
64	Ives and Clinton, '79	.9936	9.28	11.61	2.49	.208	do	.709	.386	.258	Do.
65	Concord and Clinton, '79	.9943	9.76	12.22	2.38	.202	do	.754	.398	.285	Do.
84	Franklin, '68	.9955	8.77	11.00	2.32	.166	do	.859	.362	.398	Julius Hincke.
87	Iolhink, '68	.9935	8.72	10.91	1.96	.151	do	.830	.323	.406	Do.
74	Ruby Claret, '75	.9910	9.73	12.13	2.22	.156	do	.726	.475	.201	J. H. Bannihr.
75	Ruby Claret, '76	.9917	10.30	12.87	2.06	.186	do	.696	.463	.186	Do.
76	Ruby Claret, '77	.9927	9.56	11.96	1.94	.165	do	.695	.438	.206	Do.
77	Ruby Claret, '78	.9902	11.82	14.74	1.87	.149	do	.667	.373	.395	Do.
78	Ruby Claret, '79	.9918	10.15	12.68	1.84	.154	do	.650	.399	.201	Do.
79	Ruby Claret, '80	.9922	10.75	13.43	1.82	.183	do	.544	.372	.138	Do.
80	Clevener, '76	.9984	6.99	8.80	2.15	.250	do	.511	.264	.198	Do.
81	Cynthiana, '76	.9939	7.94	9.95	2.28	.208	do	.770	.528	.193	Do.
82	Franklin, '76	.9945	8.64	10.82	2.01	.180	do	.724	.347	.302	Do.
83	Norton's Virginia, '77	.9914	10.38	12.96	1.87	.166	do	.635	.287	.278	Do.
155	Ives' Seedling, '80	.9925	9.43	11.79	1.98	.238	do	.568	.287	.225	Poeschel, Scherer & Co.
157	Cynthiana, '80	.9952	9.26	11.61	2.66	.343	do	.561	.289	.218	Do.
158	Clinton, '80	.9894	12.21	15.21	2.20	.285	do	.540	.309	.185	Do.
160	Virginia Seedling, '80	.9950	9.89	12.40	3.00	.365	do	.494	.302	.154	Do.

162	Concord, '80	.9913	10.38	12.96	1.76	.233	Trace	.496	.302	.155	Poeschel, Scherer & Co.
139	Sonoma Red Mission, '79	.9968	7.99	10.03	2.42	.428	None	.722	.301	.337	Gretsch & Mayer.
147	Sonoma Red Zinfandell, '79	.9962	7.80	9.78	2.43	.255	Trace	.693	.391	.242	Do.
154	Virginia Concord, '79	.9965	7.60	9.54	2.11	.231	do	.753	.421	.266	Do.
89	Concord	.9944	8.43	10.56	1.85	.130	do	.648	.272	.301	Isaac Cook.
90	Virginia Seedling	.9938	9.62	12.05	2.06	.218	do	.664	.226	.350	Do.
91	Fine Claret	.9937	9.21	11.52	1.97	.189	do	.664	.287	.302	Do.
92	Burgundy	.9940	9.21	11.52	2.03	.210	do	.664	.242	.178	Do.
120	"I and N," '80	.9949	8.22	10.30	2.09	.318	None	.754	.362	.314	Wehrle, Werk & Co.
121	Norton, '80	.9888	12.14	15.12	2.32	.176	Trace	.516	.258	.206	Do.
122	Ives, '80	.9961	6.59	8.27	1.72	.198	None	.602	.346	.205	Do.
124	Concord, '80	.9947	8.14	10.21	2.17	.209	do	.618	.347	.217	Do.
15	Black Rose	.9920	9.86	12.31	1.94	.170	Trace	.756	.287	.375	Charles Saalmann.
56	"Old Dominion"	.9970	6.16	7.74	1.65	.169	.14	.707	.277	.344	C. A. Heineken.
126	"Old Dominion"	.9967	7.01	8.80	2.39	.152	Trace	.782	.391	.313	Do.
127	"Prince William"	.9945	10.20	12.77	3.16	.297	do	.699	.317	.306	Do.
114	Mission Claret	.9975	7.39	9.29	2.40	.532	do	.917	.271	.517	B. Dreyfus & Co.
115	Red Zinfandell	.9960	9.04	11.35	2.67	.280	do	.768	.277	.393	Do.
171	Norton's Seedling, '78	.9945	9.34	11.70	2.36	.261	do	.685	.356	.271	H. T. Dewey & Son.
172	Concord and Norton, '79	.9986	7.58	9.54	2.39	.223	None	.997	.646	.281	Do.
66	Zinfandell, '78	.9957	8.21	10.30	2.45	.213	Trace	.825	.437	.310	Dresel & Co.
67	Zinfandell, '79	.9963	8.83	11.08	2.68	.188	do	.798	.376	.338	Do.
37	Zinfandell	.9947	9.83	12.31	2.56	.376	do	.814	.323	.393	George Hamlin & Co.
38	California Claret	.9964	8.41	10.56	2.43	.326	do	.903	.331	.458	
4	California Zinfandell	.9930	10.58	13.24	2.21	.237	.18	.726	.266	.368	
11	Concord Bouquet	.9928	9.84	12.31	2.18	.141	.71	.741	.272	.375	Vineland Wine Company, New Jersey.
12	Red Wine	1.0069	9.07	11.44	3.90	.185	.80	.790	.402	.310	Do.
97	Dry Concord, '80	.9913	9.44	11.79	1.66	.098	Trace	.681	.272	.327	W. J. Green. Tokay Vineyards.
136	Ives, '74	1.0006	5.69	7.17	2.68	.193	do	.764	.420	.275	White Elk Vineyards.
180	Red Concord	.9953	7.34	9.21	1.87	.197	None	.838	.377	.289	Fritz Baier.
181	Clinton	.9944	9.27	11.61	2.50	.217	do	.778	.483	.236	Do.
182	Norton's	.9933	10.66	13.34	2.70	.358	do	.634	.323	.249	Do.

II.—Dry White Wines.

1	California White Hoc	.9892	13.94	17.37	2.62	0.243	0.09	0.855	0.231	0.311	
5	Missouri	.9908	10.68	13.34	1.45	.204	.05	.547	.227	.256	
6	Riesling	.9902	10.55	13.05	1.62	.181	.04	.620	.227	.314	
8	California Hock	.9913	10.29	12.87	1.44	.147	.09	.767	.378	.311	
9	California Muscatel	.9913	10.67	13.34	1.41	.190	.12	.767	.272	.396	
7	Catawba, Ohio	.9930	9.91	12.40	2.22	.154	.19	.632	.302	.264	Lenk Wine Company.
13	California Sonoma Hock	.9845	9.66	12.05	1.18	.190	.13	.422	.213	.167	Perkins, Stern & Co.
21	Virginia Hock, '79	.9905	9.58	11.96	1.39	.166	Trace	.636	.378	.206	Monticello Wine Company.
29	White Concord, '75	.9954	8.42	10.56	2.64	.160	None	.789	.332	.366	White Elk Vineyards.
45	Catawba	.9903	10.99	13.71	2.10	.135	Trace	.833	.480	.282	Pleasant Valley Wine Company.
180	Catawba	.9928	10.52	13.15	2.19	.140		.542	.470	.068	Do.
48	Brocton Catawba	.9890	12.28	15.30	2.09	.121	.26	.789	.385	.323	G. E. Ryckman.
50	California Riesling Hock	.9932	9.00	11.26	1.67	.223	Trace	.846	.211	.508	Dresel & Co.
68	California Hock	.9935	9.07	11.35	1.92	.208	do	.785	.242	.354	Do.

ANALYSES OF AMERICAN WINES—Continued.

II.—Dry White Wines—Continued.

No.	Name.	Specific gravity.	Per cent. alcohol, by weight.	Per cent. alcohol, by volume.	Per cent. total residue.	Per cent. total ash.	Per cent. glucose.	Per cent. total acid, as tartaric.	Per cent. fixed acid, as tartaric.	Per cent. volatile acid, as acetic.	Maker.
72	Catawba	.9938	7.75	9.70	1.34	.117	.16	.528	.272	.205	Kelly Island Wine Co.
85	Jersica, '68	.9919	9.64	12.05	1.91	.138	Trace	.726	.287	.351	Julius Hincke.
86	Catawba, '68	.9944	7.16	8.96	1.44	.167	....do	.800	.350	.280	Do.
93	Catawba, Missouri	.9911	8.88	11.08	1.67	.129	....do	.772	.387	.308	Isaac Cook.
106	Dry Muscat	.9928	9.14	11.44	1.82	.150	....do	.619	.248	.289	Dreyfus & Co.
107	White Zinfandell	.9911	9.02	11.26	1.47	.139	....do	.590	.227	.290	Do.
108	Riesling	.9918	9.64	12.05	1.72	.221	....do	.696	.210	.389	Do.
109	Gutedel	.9920	9.36	11.70	1.58	.196	....do	.726	.212	.411	Do.
110	Hock	.9959	7.73	9.70	1.73	.209	....do	.723	.211	.410	Do.
118	"A. A" Catawba, second quality	.9929	7.69	9.62	1.29	.192	None	.710	.257	.362	Wehrle, Werk & Co.
119	"A. A. A" Catawba, first quality	.9912	9.09	11.35	1.28	.164	Trace	.772	.309	.371	Do.
123	Delaware	.9940	7.03	8.80	1.51	.255	None	.664	.226	.350	Do.
125	"Mount Vernon"	.9962	7.73	9.70	2.07	.202	.30	.669	.286	.306	C. A. Heineken.
128	Native wine, N. Mex., '77	.9894	10.55	13.15	1.80	.275	Trace	.485	.121	.291	L. & H. Huning.
138	Sonoma Mission, '78	.9932	8.44	10.56	1.63	.184	....do	.619	.311	.246	Gretsch & Mayer.
140	Sonoma Riesling, '77 (?)	.9926	10.53	13.15	2.28	.223	....do	.695	.332	.290	Do.
141	Sonoma Riesling, '79	.9906	10.54	13.15	1.70	.194	....do	.575	.257	.254	Do.
142	Sonoma Mission, '79	.9935	8.30	10.38	1.67	.193	....do	.619	.317	.242	Do.
143	Sonoma Gutedel, '79	.9921	9.50	11.87	1.71	.197	....do	.589	.287	.242	Do.
144	Dry Muscat, '74 (?)	.9921	9.92	12.40	1.66	.256	....do	.816	.302	.411	Do.
145	White Zinfandell, '78	.9928	9.56	11.96	1.96	.211	....do	.761	.393	.324	Do.
146	White Zinfandell, '79	.9927	8.80	11.00	1.87	.182	....do	.740	.332	.326	Do.
148	Ohio Catawba, '79	.9892	10.25	12.77	1.63	.113	....do	.728	.424	.243	Do.
149	Ohio Catawba, '80	.9935	9.28	11.61	1.80	.111	....do	.628	.468	.128	Do.
150	Helena (?) '79	.9954	7.80	9.78	2.06	.229	....do	.693	.271	.250	Do.
156	Riesling, '80	.9956	8.08	10.38	2.00	.335	None	.603	.349	.203	Poeschel, Scherer & Co.
159	Ruländer, '80	.9914	10.46	13.05	1.90	.199	Trace	.545	.302	.194	Do.
161	Delaware, '80	.9932	9.35	11.70	1.88	.255	....do	.562	.332	.184	Do.
165	Taylor, '80	.9921	10.37	12.96	1.99	.185	....do	.732	.317	.332	Do.
166	Goethe, '80	.9962	8.55	10.73	1.85	.223	....do	.693	.301	.314	Do.
173	Catawba, '79	.9941	7.55	9.45	1.57	.114	None	.830	.468	.290	H. T. Dewey & Son.
175	Iona and Catawba, '71	.9906	9.73	12.13	1.91	.103	Trace	.742	.469	.218	Do.
176	Iona, '70	.9892	12.05	15.02	1.62	.090	....do	.810	.561	.199	Do.
178	Catawba, '80	.9937	7.62	9.54	1.39	.148	....do	.755	.317	.350	Fritz Baier.
179	White Concord, '80	1.0105	8.02	10.21	1.34	.183	....do	.481	.252	.183	Do.
163	Herbemont, '80	.9928	7.78	9.86	1.60	.146	None	.562	.302	.208	Poeschel, Scherer & Co.
164	Catawba, '80	.9934	8.64	10.82	1.63	.178	Trace	.574	.362	.170	Do.
134	White Concord, '75	1.0022	7.03	8.88	3.66	.158	1.20	.784	.404	.304	White Elk Vineyards.

III.—Sweet Wines.

	PORT WINES.										
28	Port, Iowa	1.0116	10.25	13.05	6.89	0.178	4.15	0.697	0.430	0.214	White Elk Vineyards.
40	Port, New York	1.0207	13.77	17.70	9.83	.142	7.77	.808	.548	.208	Pleasant Valley Wine Company.
41	California Port	1.0258	16.93	21.89	11.43	.467	8.60	.790	.307	.386	
46	Brocton Port, New York	1.0508	10.00	13.24	17.04	.139	11.80	.828	.600	.182	G. E. Ryckman.
52	California Port	1.0297	16.10	20.89	12.37	.285	5.78	.510	.320	.152	Kohler & Frohling.
57	Speer's Port, New Jersey	1.0213	13.67	17.59	10.69	.309	7.41	.705	.347	.286	Alfred Speer.
70	California Port	1.0139	14.78	18.88	8.56	.355	4.49	.755	.320	.348	Dreyfus & Co.
111	California Port	1.0122	15.58	19.87	8.36	.347	5.88	.370	.196	.139	Do.
103	California Port	1.0228	12.03	15.49	10.33	.300	8.60	.486	.238	.198	Perkins, Stern & Co.
10	"Sunny Slope," California	1.0405	11.53	15.12	12.96	.336	11.57	.433	.259	.138	Do.
129	Port, New York	1.0296	11.44	14.84	11.45	.190	9.18	.693	....	....	Pleasant Valley Wine Company.
153	Los Angeles, California	1.0339	12.68	16.52	14.18	.345	11.39	.508	.348	.128	Gretsch & Mayer.
	SHERRY WINES.										
39	California Sherry	.9873	14.42	17.92	1.95	.197	.61	.532	.231	.241	
2	Sherry, New York	1.0074	13.87	17.59	6.83	.166	4.84	.689	.209	.323	Urbana Wine Company.
53	Sherry	.9944	20.09	25.17	5.17	.479	2.97	.694	.332	.290	Perkins, Stern & Co.
105	Marsala	1.0052	16.06	20.33	6.42	.428	3.53	.626	.418	.166	Do.
69	California Sherry	.9987	12.84	16.15	4.70	.202	2.45	.721	.246	.380	Dreyfus & Co.
113	California Sherry	.9942	13.42	16.80	3.91	.198	2.20	.573	.232	.273	Do.
58	Speer's Sherry	.9949	17.62	22.09	4.89	.219	3.33	.476	.271	.164	Alfred Speer.
	CHAMPAGNES.										
14	"Dry Sillery"	1.0293	9.22	11.96	10.70	.104	7.34	.685	.438	.198	Henriot & Co. (?)
24	"Great Western," extra dry	1.0268	9.05	11.10	10.41	.131	9.08	.818	.365	.362	Pleasant Valley Wine Company.
132	"Great Western," extra dry	1.0285	8.35	10.82	11.07	.130	8.79	.501	.394	.186	Do.
25	"Grand Prize," medium dry	1.0228	9.75	12.49	9.15	.134	8.21	.821	.323	.398	Arpad Haraszthy.
26	"Eclipse," extra dry	1.0174	9.26	11.87	7.78	.149	6.51	.885	.295	.472	Do.
27	"Gold Seal"	1.0402	8.26	10.82	13.31	.110	12.02	.880	.447	.346	Urbana Wine Company.
55	"Sans Pareil"	1.0272	5.78?	7.48?	9.00	.147	8.74	.862	.438	.339	William H. Mills.
167	"Sans Pareil"	1.0308	8.07	10.47	10.30	.153	8.78	.825	.626	.159	Do.
168	La Diamant	1.0217	8.40	10.82	8.73	.138	7.54	.564	.411	.122	Do.
169	Norton's Virginia (red), '72	1.0188	6.24	8.01	8.58	.164	7.24	.692	.515	.142	Do.
88	Cook's Imperial	1.0207	8.41	10.82	8.47	.130	7.23	.779	.470	.247	Isaac Cook.
101	Cook's Imperial	1.0222	7.03	9.04	7.80	.114	7.02	.851	.411	.352	Do.
102	"Red Cross" (red)	1.0264	10.02	12.96	11.23	....	10.11	.570	.322	.198	M. Werk & Son.
183	"Red Cross" (red)	1.0265	8.58	11.08	11.01	.102	9.01	.567	.386	.145	Do.
174	Catawba, '78	1.0233	7.64	9.86	8.57	.114	6.60	.572	.423	.119	H. T. Dewey & Son.
	SWEET CATAWBAS.										
73	Bass Island	1.0338	11.68	15.21	14.49	.152	11.00	.595	.296	.239	
30	Iowa, '71	1.0101	9.89	12.58	7.23	.211	4.01	.668	.318	.280	White Elk Vineyards.
44	New York	1.0219	12.98	16.70	11.13	.120	8.98	.519	.382	.110	Pleasant Valley Wine Company.
131	New York	1.0231	13.40	17.26	10.78	.140	8.87	.367	.289	.063	Do.
184	New York	1.0199	15.40	19.78	11.42	.126	9.49	.560	.406	.123	Do.
47	Brocton, New York	1.0512	10.71	14.18	16.71	.113	15.22	.714	.471	.194	G. E. Ryckman.

ANALYSES OF AMERICAN WINES—Continued.

III.—SWEET WINES—Continued.

No.	Name.	Specific gravity.	Per cent. alcohol, by weight.	Per cent. alcohol, by volume.	Per cent. total residue.	Per cent. total ash.	Per cent. glucose.	Per cent. total acid, as tartaric.	Per cent. fixed acid, as tartaric.	Per cent. volatile acid, as acetic.	Maker.
	MISCELLANEOUS.										
54	Sweet Muscatel	1.1022	13.51	18.58	31.34	.371	25.37	.753	.421	.266	Perkins, Stern & Co.
71	Sweet Muscatel	1.0245	17.33	22.36	11.70	.218	11.59	.366	.234	.106	Dreyfus & Co.
117	Sweet Muscatel	1.0437	17.08	22.46	17.09	.126	16.94	.331	.273	.046	Do.
151	Los Angeles Muscatel	1.0418	12.81	17.08	15.61	.173	13.44	.533	.360	.138	Gretsch & Mayer.
42	California Angelica	1.0440	8.96	11.79	14.41	.196	12.48	.489	.310	.143	
104	California Angelica	1.0381	10.63	13.90	13.63	.249	13.25	.347	.254	.074	Perkins, Stern & Co.
116	California Angelica	1.0465	13.77	18.14	15.94	.230	14.81	.430	.315	.092	Dreyfus & Co.
152	Los Angeles Angelica	1.0493	14.77	18.78	18.04	.177	16.20	.466	.314	.122	Gretsch & Mayer.
49	Brocton Sweet Regina	1.0515	9.71	12.87	16.52	.101	15.31	.628	.465	.130	G. E. Ryckman.
51	Gerke's White Wine	1.0023	11.67	14.74	5.42	.341	2.21	.673	.245	.342	Henry Gerke.
95	Sweet Delaware, '79	1.0320	8.73	11.35	12.07	.118	10.27	.799	.355	.355	W. J. Green.
96	Sweet Concord, '80	1.0224	8.48	10.91	8.41	.132	7.12	.601	.358	.194	Do.
98	Scuppernong, '80	1.0100	8.50	10.82	5.71	.111	1.78	.653	.252	.321	Do.
99	Scuppernong, sweet, '78	1.0404	9.06	11.87	14.13	.132	11.56	.758	.323	.348	Do.
100	Scuppernong, dry, '79	.9948	10.72	13.43	3.39	.108	1.31	.925	.346	.463	Do.
94	Norton's Virginia "Claret," '80	.9962	12.27	15.40	3.61	.126	1.31	.828	.295	.426	Do.
43	California Malaga	1.0239	13.72	17.70	11.00	.423	8.59	.659	.264	.316	Henry Gerke.
177	Delaware, '75	1.0111	7.74	9.86	6.45	.260	3.36	.593	.430	.130	H. T. Dewey & Son.
	BRANDIES.										
23	Pure Grape	.9272	46.00	53.70	.125	....	....	....	....	.111	Monticello Wine Company.
112	Pure Grape	.9341	43.66	51.38	....	....	....	....	....	....	B. Dreyfus & Co.
170	Brandy, '76	.9399	43.81	51.58	....	....	Trace	....	....	.075	H. T. Dewey & Son.

IV.—AVERAGES AND EXTREMES.

AMERICAN DRY WINES.

Constituents, &c.	Dry red wines. Average (sixty-four analyses).	Dry red wines. Highest.	Dry red wines. Lowest.	Dry white wines. Average (fifty-one analyses).	Dry white wines. Highest.	Dry white wines. Lowest.
Specific gravity	.9933	1.0011	.9894	.9926	1.0105	.9845
Per cent. alcohol, by weight	8.92	12.21	5.71	9.35	13.94	7.03
Per cent. alcohol, by volume	11.04	15.21	7.17	11.70	17.37	8.80
Per cent. total residue	2.28	3.16	1.65	1.75	2.64	1.18
Per cent. total ash	0.231	0.532	0.130	0.181	0.335	0.090
Per cent. glucose	Traces.	0.450	None.	Traces.	0.300	None.
Per cent. total acid, as tartaric	0.723	0.997	0.511	0.680	0.855	0.422
Per cent. fixed acid, as tartaric	0.360	0.646	0.226	0.313	0.561	0.121
Per cent. volatile acid, as acetic	0.290	0.517	0.138	0.294	0.508	0.068

I wish to acknowledge the valuable aid rendered by my assistants, Messrs. Charles Wellington, Clifford Richardson, and Henry B. Parsons, who were all engaged on the work relating to sugar.

In addition, Mr. Richardson has had charge of the work on grasses, Mr. Parsons of the work on wines, and Mr. Wellington of the work on tannin.

Respectfully submitted.

PETER COLLIER,
Chemist.

HON. WM. G. LE DUC,
Commissioner.

REPORT OF THE STATISTICIAN.

SIR: My report as Statistician of the Department of Agriculture is respectfully submitted.

The estimate of the different crops and the numbers of live stock for the year 1880 is based on the enumeration of the census taken in June of that year, as far as has been practicable, but the enumeration, at this date, is not available for some of the States and Territories; where such is the case, I have made the estimates from our own tables for 1879.

CROPS OF 1880.

Corn.—The area planted in this crop was slightly more than that planted in 1879. The spring was very favorable for planting, with some complaints of too much rain in the States north of the Ohio River and west of the Mississippi.

During the summer drought was injurious in the South Atlantic States to a limited extent, while the States of the Lower Mississippi suffered from too much rain. The early fall of snow, added to the almost unprecedented rainfall in the West and Southwest during the autumn, caused a serious loss to the aggregate of the crop, owing to the fact that much was still standing in the fields at that date. The yield per acre, for the whole country, however, shows that it was 27.5 bushels per acre, thus making a crop of 1,717,000,000 bushels.

Wheat.—The winter of 1879-'80 was an unusually mild and open one, and the injuries to fall-sown wheat were inconsiderable, except in those localities in the Northwest where many farmers tried the experiment of fall-sown wheat instead of the usual spring sowing; there, owing to a lack of snow covering, the injury was almost universal.

The increase in area sown in this crop was very great, and was estimated at 11 per cent. This increase was almost entirely in fall-sown grain, the area in spring wheat showing but slight change from the year previous.

The conditions of the crop during growth were favorable, although in all sections south of the Ohio River there were complaints of drought and rust. The season in the Northwest was better than either of the two preceding years, inasmuch as the hot wave which swept over that section those years was not felt this season. On the Pacific coast the season was all that could be desired.

The yield per acre for the whole country is 13.1 bushels, and the crop is estimated at 498,000,000 bushels.

Cotton.—Since two years the price of cotton, together with the returning prosperity of the whole country, has stimulated the production to a great degree.

The increase in area planted was estimated in June at 7 per cent. more than the previous year, but later developments showed that the estimate was too low, as well as the estimate for 1879; therefore it was with much interest that the enumeration in the census of the number of acres planted in this staple was watched. Besides, this was the first enumeration of the areas sown and planted ever included in the agricultural schedule of the census.

It is now ascertained that in 1880, 15,475,000 acres were planted in cotton.

The weather during the spring and summer months was very favorable, and the crop was in a very forward state, being some two weeks earlier than usual. In the fall months there was too much rain, particularly in the States of the Mississippi Valley, and the expectations of an excess in the yield per acre for the cotton belt were not realized, but the increase in area planted more than counterbalanced the loss in yield. The result was a crop largely in excess of that of 1879.

Tobacco.—The crop of tobacco fell short, to a considerable extent, as compared with the crop of 1879.

The cause of the decline was a decrease in the area planted in most of those States where the crop is the largest. In Virginia and Maryland, owing to an unfavorable season for planting and a great scarcity of plants, there was reported a reduction of nearly 20 per cent. in acreage. In Kentucky and Tennessee there was also a decrease, but slight as compared with the two States mentioned above. In Ohio, Pennsylvania, and Connecticut there was an increase of acreage.

The weather in July and August was not favorable, but later in the season it was, and the crop that was grown made rapid improvement, and was nearly an average yield per acre, and of superior quality.

Other crops.—For details of other crops, reference is made to the following tables:

Table showing the product of each principal crop of the several States named, the yield per acre, the total acreage, the average price in each State, and the value of each crop, for 1880.

Products.	Quantity produced in 1880.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
MAINE.					
Indian corn.....bushels..	1,108,020	35.4	31,300	$0 77	$853,175
Wheat.....do.....	531,204	12	44,267	1 47	780,870
Rye.....do.....	39,382	15.3	2,574	96	37,807
Oats.....do.....	2,012,825	25	80,513	48	966,156
Barley.....do.....	238,779	21.5	11,106	79	188,635
Buckwheat.....do.....	480,000	25	19,200	50	240,000
Potatoes.....do.....	5,154,190	107	48,170	48	2,474,011
Tobacco.....pounds..	....	....	....	....	....
Hay.....tons..	1,297,296	1.01	1,284,451	12 67	16,436,740
Total.....	....	....	1,521,581	....	21,977,394
NEW HAMPSHIRE.					
Indian corn.....bushels..	1,401,820	38	36,890	73	1,023,329
Wheat.....do.....	158,200	14	11,300	1 40	221,480
Rye.....do.....	48,960	16	3,060	95	46,512
Oats.....do.....	891,840	30	29,728	48	428,083
Barley.....do.....	90,500	25.4	3,563	79	71,495
Buckwheat.....do.....	102,156	22.3	4,581	65	66,401
Potatoes.....do.....	3,786,300	105	36,060	44	1,665,972
Tobacco.....pounds..	....	....	....	....	....
Hay.....tons..	592,764	.90	658,627	13 37	7,925,255
Total.....	....	....	783,809	....	11,448,527
VERMONT.					
Indian corn.....bushels..	1,801,600	32	56,300	71	1,279,136
Wheat.....do.....	314,325	15	20,955	1 33	418,052
Rye.....do.....	102,456	18	5,692	84	86,063
Oats.....do.....	3,185,536	32	99,548	45	1,433,491
Barley.....do.....	306,574	28.3	10,833	75	229,930
Buckwheat.....do.....	348,400	20	17,420	58	202,072

Table showing the product of each principal crop, &c., for 1880—Continued.

Products.	Quantity produced in 1880.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
VERMONT—Continued.					
Potatoes .... bushels..	4,954,740	141	35,140	$0 42	$2,080,991
Tobacco .... pounds..	....	....		....	....
Hay .... tons..	1,182,030	1.08	1,094,472	10 40	12,293,112
Total	....	....	1,340,360	....	18,022,847
MASSACHUSETTS.					
Indian corn .... bushels..	1,875,330	33.5	55,980	75	1,406,497
Wheat .... do....	18,921	17	1,113	1 30	24,597
Rye .... do....	431,550	17.5	24,660	92	397,026
Oats .... do....	717,309	31	23,139	53	380,174
Barley .... do....	73,282	22	3,331	88	64,488
Buckwheat .... do....	104,240	20	5,212	60	62,544
Potatoes .... do....	5,244,120	126	41,620	51	2,674,501
Tobacco .... pounds..	4,927,840	1,520	3,242	15	739,176
Hay .... tons..	863,691	1.08	799,714	18 33	15,831,456
Total	....	....	958,011	....	21,580,459
RHODE ISLAND.					
Indian corn .... bushels..	363,180	30	12,106	90	326,862
Wheat .... do....	....	....	....	....	....
Rye .... do....	27,555	15	1,837	1 00	27,555
Oats .... do....	167,250	30	5,575	53	88,642
Barley .... do....	....	....	....	....	....
Buckwheat .... do....	....	....	....	....	....
Potatoes .... do....	444,000	75	5,920	60	266,400
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	108,015	.75	144,020	16 00	1,728,240
Total	....	....	169,458	....	2,437,699
CONNECTICUT.					
Indian corn .... bushels..	1,621,100	29	55,900	75	1,215,825
Wheat .... do....	39,582	18	2,199	1 40	55,415
Rye .... do....	442,380	14.6	30,300	87	384,871
Oats .... do....	1,038,355	28.3	36,691	53	550,328
Barley .... do....	....	....	....	....	....
Buckwheat .... do....	162,313	14.5	11,194	62	100,634
Potatoes .... do....	2,795,310	87	32,130	60	1,677,186
Tobacco .... pounds..	15,487,660	1,538	10,070	15	2,323,149
Hay .... tons..	760,550	1	760,550	16 00	12,168,800
Total	....	....	939,034	....	18,476,208
NEW YORK.					
Indian corn .... bushels..	27,895,680	34.8	801,600	57	15,900,538
Wheat .... do....	12,609,200	16	788,075	1 17	14,752,764
Rye .... do....	3,611,471	15.7	230,030	83	2,997,521
Oats .... do....	40,004,318	30.5	1,311,617	44	17,601,900
Barley .... do....	8,246,745	23.4	352,425	83	6,844,798
Buckwheat .... do....	5,135,652	18	285,314	53	2,721,896
Potatoes .... do....	32,571,900	90	361,910	42	13,680,198
Tobacco .... pounds..	6,572,800	1,280	5,135	12	788,736
Hay .... tons..	5,047,920	1.04	4,853,769	15 90	80,261,928
Total	....	....	8,989,875	....	155,550,279
NEW JERSEY.					
Indian corn .... bushels..	14,235,200	41	347,200	0 58	8,256,416
Wheat .... do....	2,460,563	15.5	158,746	1 17	2,878,859
Rye .... do....	1,297,362	13.3	97,546	90	1,167,626
Oats .... do....	3,523,500	27	130,500	41	1,444,635
Barley .... do....	....	....	....	....	....
Buckwheat .... do....	562,240	17.5	32,128	64	359,834
Potatoes .... do....	4,239,280	76	55,780	56	2,373,997
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	489,214	.99	494,156	19 12	9,353,772
Total	....	....	1,316,056	....	25,885,139

Table showing the product of each principal crop, &c., for 1880—Continued.

Products.	Quantity produced in 1880.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
PENNSYLVANIA.					
Indian corn .... bushels..	55,804,700	40.6	1,374,500	$0 53	$29,576,491
Wheat .... do....	22,114,380	15	1,474,292	1 09	24,104,674
Rye .... do....	5,857,425	15	390,495	76	4,451,643
Oats .... do....	35,721,420	30	1,190,714	37	13,216,925
Barley .... do....	499,776	24	20,824	84	419,812
Buckwheat .... do....	4,109,291	17	241,723	62	2,547,760
Potatoes .... do....	13,436,320	79	170,080	48	6,449,434
Tobacco .... pounds..	34,854,108	1,172	29,739	10	3,485,411
Hay .... tons..	2,727,360	1.07	2,548,935	16 40	44,728,704
Total	....	....	7,441,302	....	128,980,854
DELAWARE.					
Indian corn .... bushels..	6,467,840	32	202,120	50	3,233,920
Wheat .... do....	1,509,785	15.4	98,038	1 15	1,736,253
Rye .... do....	8,889	11.5	773	73	6,489
Oats .... do....	312,930	18.3	17,100	38	118,913
Barley .... do....	....	....	....	....	....
Buckwheat .... do....	....	....	....	....	....
Potatoes .... do....	308,000	70	4,400	57	175,560
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	26,642	.83	32,099	18 33	488,348
Total	....	....	354,530	....	5,759,483
MARYLAND.					
Indian corn .... bushels..	21,702,080	32	678,190	49	10,634,019
Wheat .... do....	8,486,380	14	606,170	1 14	9,674,473
Rye .... do....	364,820	12.6	28,954	86	313,745
Oats .... do....	2,278,320	24	94,930	38	865,762
Barley .... do....	....	....	....	....	....
Buckwheat .... do....	190,530	19.3	9,872	67	127,655
Potatoes .... do....	855,920	52	16,460	56	479,315
Tobacco .... pounds..	18,841,830	705	26,726	07	1,318,928
Hay .... tons..	174,666	.85	205,489	17 05	2,978,055
Total	....	....	1,666,791	....	26,391,952
VIRGINIA.					
Indian corn .... bushels..	45,230,000	25	1,809,200	42	18,996,600
Wheat .... do....	8,737,302	9.5	919,716	1 05	9,174,167
Rye .... do....	366,400	8	45,800	68	249,152
Oats .... do....	5,774,780	11	524,980	41	2,367,660
Barley .... do....	....	....	....	....	....
Buckwheat .... do....	306,577	18.9	16,221	65	199,275
Potatoes .... do....	1,394,350	79	17,650	46	641,401
Tobacco .... pounds..	78,421,860	660	118,821	08	6,273,749
Hay .... tons..	169,323	1.30	130,248	13 07	2,213,052
Total	....	....	3,582,636	....	40,115,056
NORTH CAROLINA.					
Indian corn .... bushels..	36,954,120	16.4	2,253,300	52	19,216,142
Wheat .... do....	4,871,213	6.4	761,127	1 15	5,601,895
Rye .... do....	475,664	8	59,458	74	351,991
Oats .... do....	5,515,400	11	501,400	51	2,812,854
Buckwheat .... do....	86,976	16	5,436	54	46,967
Potatoes .... do....	1,272,600	105	12,120	67	852,642
Tobacco .... pounds..	35,724,385	565	63,229	09	3,215,195
Hay .... tons..	113,664	1.53	74,290	10 55	1,199,155
Cotton .... pounds..	184,734,000	198	933,000	10	18,473,400
Total	....	....	4,663,360	....	51,770,24
SOUTH CAROLINA.					
Indian corn .... bushels..	11,745,900	9.3	1,263,000	77	9,044,343
Wheat .... do....	869,530	4.8	181,152	1 44	1,252,123
Rye .... do....	32,800	5	6,560	1 27	41,656
Oats .... do....	3,688,020	14	263,430	71	2,618,494

Table showing the product of each principal crop, &c., for 1880—Continued.

Products.	Quantity produced in 1880.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
SOUTH CAROLINA—Continued.					
Barley .... bushels..	....	....	....	....	....
Potatoes .... do....	90, 850	79	1, 150	$0 86	$78, 131
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	20, 412	1. 35	15, 120	18 45	376, 601
Cotton .... pounds..	266, 696, 000	185	1, 441, 600	11	29, 336, 560
Total	....	....	3, 172, 012	....	42, 747, 908
GEORGIA.					
Indian corn .... bushels..	21, 939, 240	9. 2	2, 384, 700	69	15, 138, 076
Wheat .... do....	3, 055, 374	6. 3	484, 980	1 36	4, 155, 309
Rye .... do....	156, 702	6	26, 117	1 23	192, 743
Oats .... do....	6, 184, 700	10	618, 470	75	4, 638, 525
Barley .... do....	22, 290	15	1, 486	62	13, 820
Potatoes .... do....	441, 600	92	4, 800	1 10	485, 760
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	34, 650	1. 88	18, 431	16 00	554, 400
Cotton .... pounds..	454, 166, 900	163	2, 786, 300	10	45, 416, 690
Total	....	....	6, 325, 284	....	70, 595, 323
FLORIDA.					
Indian corn .... bushels..	3, 522, 180	9. 4	374, 700	85	2, 993, 853
Wheat .... do....	....	....	....	....	....
Rye .... do....	....	....	....	....	....
Oats .... do....	436, 050	9. 5	45, 900	1 21	414, 247
Barley .... do....	....	....	....	....	....
Potatoes .... do....	....	....	....	....	....
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	....	....	....	....	....
Cotton .... pounds..	35, 727, 200	142	251, 600	09	3, 215, 448
Total	....	....	672, 200	....	6, 625, 548
ALABAMA.					
Indian corn .... bushels..	22, 679, 352	12. 4	1, 828, 980	67	15, 195, 166
Wheat .... do....	1, 402, 218	5. 4	259, 670	1 21	1, 696, 684
Rye .... do....	32, 906	5. 7	5, 773	1 04	34, 222
Oats .... do....	2, 926, 336	9. 2	318, 080	73	2, 136, 225
Barley .... do....	....	....	....	....	....
Potatoes .... do....	370, 510	79	4, 690	77	285, 293
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	34, 900	1. 64	21, 280	14 87	518, 963
Cotton .... pounds..	378, 932, 400	154	2, 460, 600	10	37, 893, 240
Total	....	....	4, 899, 073	....	57, 759, 793
MISSISSIPPI.					
Indian corn .... bushels..	23, 218, 380	14. 6	1, 590, 300	63	14, 627, 579
Wheat .... do....	281, 166	6. 8	41, 348	1 29	362, 704
Rye .... do....	....	....	....	....	....
Oats .... do....	3, 021, 000	15	201, 400	66	1, 993, 860
Barley .... do....	....	....	....	....	....
Potatoes .... do....	404, 000	100	4, 040	89	359, 560
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	28, 288	1. 61	17, 570	13 90	393, 203
Cotton .... pounds..	391, 300, 000	172	2, 275, 000	10	39, 130, 000
Total	....	....	4, 129, 658	....	56, 866, 906
LOUISIANA.					
Indian corn .... bushels..	14, 912, 720	19	784, 880	61	9, 096, 759
Wheat .... do....	....	....	....	....	....
Rye .... do....	....	....	....	....	....
Oats .... do....	405, 000	15	27, 000	58	234, 900
Barley .... do....	....	....	....	....	....
Potatoes .... do....	....	....	....	....	....
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	....	....	....	....	....

Table showing the product of each principal crop, &c., for 1880—Continued.

Products.	Quantity produced in 1880.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
LOUISIANA—Continued.					
Cotton .... pounds..	161, 616, 000	182	888, 000	$0 10	$16, 161, 600
Sugar .... do....	272, 980, 000	1, 716	159, 079	06	16, 378, 800
Total	....	....	1, 858, 959	....	41, 872, 059
TEXAS.					
Indian corn .... bushels..	66, 754, 500	25	2, 670, 180	53	35, 379, 885
Wheat .... do....	3, 008, 112	8	376, 014	1 05	3, 158, 518
Rye .... do....	40, 482	13	3, 114	90	36, 434
Oats .... do....	6, 936, 540	26	266, 790	46	3, 190, 808
Barley .... do....	149, 760	26	5, 760	67	100, 339
Potatoes .... do....	753, 460	101	7, 460	1 14	858, 944
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	196, 500	1. 93	101, 813	9 00	1, 768, 500
Cotton .... pounds..	550, 873, 000	230	2, 395, 100	09	49, 578, 570
Total	....	....	5, 826, 231	....	94, 071, 998
ARKANSAS.					
Indian corn .... bushels..	32, 350, 250	25	1, 294, 010	49	15, 851, 622
Wheat .... do....	1, 356, 068	7	193, 724	1 02	1, 383, 189
Rye .... do....	29, 520	10. 3	2, 866	86	25, 387
Oats .... do....	2, 748, 834	18	152, 713	53	1, 456, 882
Barley .... do....	....	....	....	....	....
Potatoes .... do....	976, 720	116	8, 420	74	722, 773
Tobacco .... pounds..	....	....	....	....	....
Hay .... tons..	21, 364	1. 48	14, 435	11 50	245, 686
Cotton .... pounds..	232, 243, 000	215	1, 080, 200	10	23, 224, 300
Total	....	....	2, 746, 368	....	42, 909, 839
TENNESSEE.					
Indian corn .... bushels..	62, 469, 792	22. 4	2, 788, 830	36	22, 489, 125
Wheat .... do....	7, 538, 400	6	1, 256, 400	98	7, 387, 632
Rye .... do....	257, 091	8. 5	30, 246	73	187, 676
Oats .... do....	5, 848, 570	13	449, 890	40	2, 339, 428
Barley .... do....	38, 565	15	2, 571	62	23, 910
Buckwheat .... do....	75, 440	16. 4	4, 600	63	47, 527
Potatoes .... do....	1, 174, 250	77	15, 250	50	587, 125
Tobacco .... pounds..	24, 319, 890	630	38, 603	09	2, 188, 790
Hay .... tons..	165, 842	1. 51	109, 829	12 90	2, 139, 362
Cotton .... pounds..	165, 688, 600	203	816, 200	09	14, 911, 974
Total	....	....	5, 512, 419	....	52, 302, 549
WEST VIRGINIA.					
Indian corn .... bushels..	17, 307, 000	30	576, 900	47	8, 134, 290
Wheat .... do....	5, 130, 991	12. 2	420, 573	91	4, 669, 202
Rye .... do....	189, 103	11. 4	16, 588	69	130, 481
Oats .... do....	2, 411, 600	20	120, 580	33	795, 828
Barley .... do....	....	....	....	....	....
Buckwheat .... do....	524, 388	17. 8	29, 460	57	298, 901
Potatoes .... do....	915, 000	75	12, 200	45	411, 750
Tobacco .... pounds..	2, 898, 552	712	4, 071	11	318, 841
Hay .... tons..	234, 320	1. 13	207, 363	10 94	2, 563, 461
Total	....	....	1, 387, 735	....	17, 322, 754
KENTUCKY.					
Indian corn .... bushels..	86, 039, 970	29. 1	2, 956, 700	38	32, 695, 189
Wheat .... do....	10, 564, 932	8. 7	1, 214, 360	93	9, 825, 387
Rye .... do....	867, 295	11	78, 845	82	711, 182
Oats .... do....	7, 026, 120	18	390, 340	37	2, 599, 664
Barley .... do....	430, 000	21. 5	20, 000	82	352, 600
Buckwheat .... do....	....	....	....	....	....
Potatoes .... do....	1, 716, 000	65	26, 400	49	840, 840
Tobacco .... pounds..	149, 017, 855	665	224, 087	07	10, 431, 250
Hay .... tons..	265, 226	1. 50	176, 811	$12 30	3, 262, 280
Total	....	....	5, 087, 543	....	60, 718, 392

Table showing the product of each principal crop, &c., for 1880—Continued.

Products.	Quantity produced in 1880.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total vaulation.
OHIO.					
Indian corn.....bushels..	119, 940, 000	37.5	3, 198, 400	$0 41	$49, 175, 400
Wheat.....do....	49, 790, 475	17.5	2, 845, 170	1 02	50, 786, 284
Rye.....do....	435, 120	14.7	29, 600	74	321, 989
Oats.....do....	25, 519, 200	28	911, 400	34	8, 676, 528
Barley.....do....	1, 420, 989	26.3	54, 030	78	1, 108, 371
Buckwheat.....do....	380, 311	18.3	20, 782	72	273, 824
Potatoes.....do....	10, 574, 000	85	124, 400	48	5, 075, 520
Tobacco.....pounds..	38, 434, 587	1, 083	35, 489	06	2, 306, 075
Hay.....tons..	2, 210, 400	1.24	1, 782, 581	12 16	26, 878, 464
Total.....	.....	.....	9, 001, 852	.....	144, 602, 455
MICHIGAN.					
Indian corn.....bushels..	34, 816, 001	40.7	855, 430	46	16, 015, 360
Wheat.....do....	33, 155, 865	17	1, 950, 345	97	32, 161, 189
Rye.....do....	290, 906	14	20, 779	69	200, 725
Oats.....do....	16, 415, 100	30	547, 170	35	5, 745, 285
Barley.....do....	1, 388, 240	28	49, 580	73	1, 013, 415
Buckwheat.....do....	624, 160	18.8	33, 200	61	380, 738
Potatoes.....do....	10, 897, 600	112	97, 300	41	4, 468, 016
Tobacco.....pounds..	.....	.....	.....	.....	.....
Hay.....tons..	800, 712	1.42	563, 882	12 30	9, 848, 758
Total.....	.....	.....	4, 117, 686	.....	69, 833, 486
INDIANA.					
Indian corn.....bushels..	99, 229, 300	29	3, 421, 700	40	39, 691, 720
Wheat.....do....	49, 766, 758	16.8	2, 962, 307	99	49, 269, 090
Rye.....do....	304, 038	13.3	22, 860	70	212, 827
Oats.....do....	15, 710, 978	24.7	636, 072	33	5, 184, 623
Barley.....do....	410, 000	25	16, 400	81	332, 100
Buckwheat.....do....	106, 110	13.5	7, 860	78	82, 766
Potatoes.....do....	3, 469, 200	59	58, 800	59	2, 046, 828
Tobacco.....pounds..	7, 609, 030	715	10, 642	05	380, 451
Hay.....tons..	1, 481, 760	1.48	1, 001, 189	10 30	15, 262, 128
Total.....	.....	.....	8, 137, 830	.....	112, 462, 533
ILLINOIS.					
Indian corn.....bushels..	240, 452, 896	27.2	8, 840, 180	36	86, 563, 043
Wheat.....do....	60, 958, 757	16.7	3, 650, 225	95	57, 910, 819
Rye.....do....	3, 049, 860	16.5	184, 840	73	2, 226, 398
Oats.....do....	62, 946, 510	31.8	1, 979, 450	29	18, 254, 488
Barley.....do....	1, 109, 425	22.3	49, 750	70	776, 597
Buckwheat.....do....	259, 840	16	16, 240	82	213, 069
Potatoes.....do....	11, 193, 750	75	149, 250	55	6, 156, 562
Tobacco.....pounds..	3, 912, 948	702	5, 574	05	195, 647
Hay.....tons..	2, 595, 530	1.45	1, 790, 021	8 35	21, 672, 675
Total.....	.....	.....	16, 665, 530	.....	193, 969, 298
WISCONSIN.					
Indian corn.....bushels..	33, 767, 382	33	1, 023, 254	39	13, 169, 279
Wheat.....do....	16, 654, 735	9.5	1, 753, 130	1 00	16, 654, 735
Rye.....do....	2, 329, 470	14.3	162, 900	68	1, 584, 040
Oats.....do....	30, 895, 528	31.4	983, 934	39	12, 049, 256
Barley.....do....	4, 903, 750	25	196, 150	62	3, 040, 325
Buckwheat.....do....	584, 309	17.4	33, 581	62	362, 272
Potatoes.....do....	13, 552, 110	99	136, 890	35	4, 743, 238
Tobacco.....pounds..	11, 395, 824	1, 243	9, 168	12	1, 367, 499
Hay.....tons..	982, 080	1.33	738, 406	10 00	9, 820, 800
Total.....	.....	.....	5, 037, 413	.....	62, 791, 444
MINNESOTA.					
Indian corn.....bushels..	15, 478, 050	35	442, 230	36	5, 572, 098
Wheat.....do....	40, 395, 696	13.2	3, 060, 280	87	35, 144, 256
Rye.....do....	201, 000	15	13, 400	58	116, 580
Oats.....do....	21, 069, 425	32.5	648, 290	29	6, 110, 133

Table showing the product of each principal crop, &c., for 1880—Continued.

Products.	Quantity produced in 1880.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
MINNESOTA—Continued.					
Barley.....bushels..	3,163,860	27	117,180	$0 58	$1,835,039
Buckwheat.....do....	66,130	17	3,890	67	44,307
Potatoes.....do....	4,880,040	132	36,970	34	1,659,214
Tobacco.....pounds..	.....	.....	.....	.....	.....
Hay.....tons..	1,577,702	1.81	871,659	6 00	9,466,212
Total.....	.....	.....	5,193,899	.....	59,947,839
IOWA.					
Indian corn.....bushels..	260,192,840	38	6,847,180	26	67,650,138
Wheat.....do....	33,178,205	10.4	3,190,212	82	27,206,128
Rye.....do....	1,379,932	13.4	102,980	62	855,558
Oats.....do....	49,922,400	33	1,512,800	23	11,482,152
Barley.....do....	3,887,148	22.7	171,240	52	2,021,317
Buckwheat.....do....	238,143	16.3	14,610	73	173,844
Potatoes.....do....	10,241,950	95	107,810	37	3,789,521
Tobacco.....pounds..	.....	.....	.....	.....	.....
Hay.....tons..	2,851,200	1.42	2,007,887	6 03	17,192,736
Total.....	.....	.....	13,954,719	.....	130,371,394
MISSOURI.					
Indian corn.....bushels..	160,463,408	28.4	5,650,120	36	57,766,827
Wheat.....do....	29,563,134	13.4	2,206,204	89	26,311,189
Rye.....do....	532,980	12.6	42,300	66	351,767
Oats.....do....	25,314,304	25.6	988,840	29	7,341,148
Barley.....do....	96,104	16.4	5,860	75	72,078
Buckwheat.....do....	83,742	17	4,926	61	51,083
Potatoes.....do....	6,621,720	84	78,830	47	3,112,208
Tobacco.....pounds..	11,027,720	781	14,120	08	882,218
Hay.....tons..	1,147,770	1.40	819,836	9 24	10,605,395
Total.....	.....	.....	9,811,036	.....	106,493,913
KANSAS.					
Indian corn.....bushels..	106,218,360	29.3	3,625,200	29	30,803,324
Wheat.....do....	20,336,000	10	2,033,600	70	14,235,200
Rye.....do....	513,366	13.7	37,472	49	251,549
Oats.....do....	8,582,520	22.2	386,600	32	2,746,406
Barley.....do....	270,504	13.6	19,890	54	146,072
Buckwheat.....do....	41,747	17.6	2,372	94	39,242
Potatoes.....do....	3,990,700	70	57,010	79	3,152,653
Tobacco.....pounds..	.....	.....	.....	.....	.....
Hay.....tons..	1,409,436	1.25	1,127,549	4 84	6,821,670
Total.....	.....	.....	7,289,693	.....	58,196,116
NEBRASKA.					
Indian corn.....bushels..	59,507,600	31	1,919,600	25	14,876,900
Wheat.....do....	12,922,677	8.5	1,520,315	73	9,433,554
Rye.....do....	385,320	12	32,110	57	219,632
Oats.....do....	5,284,700	21.5	245,800	26	1,374,022
Barley.....do....	1,186,680	13.2	89,900	42	498,406
Buckwheat.....do....	27,160	14	1,940	98	26,617
Potatoes.....do....	1,086,750	69	15,750	61	662,917
Tobacco.....pounds..	.....	.....	.....	.....	.....
Hay.....tons..	564,564	1.38	409,104	3 61	2,038,076
Total.....	.....	.....	4,234,519	.....	29,130,124
CALIFORNIA.					
Indian corn.....bushels..	2,580,800	32	80,650	76	1,961,408
Wheat.....do....	33,877,600	16	2,117,350	96	32,522,496
Rye.....do....	306,704	16	19,169	83	254,564
Oats.....do....	1,447,100	29	49,900	65	940,615
Barley.....do....	14,720,245	28.3	520,150	61	8,979,349
Buckwheat.....do....	17,680	17	1,040	75	13,260
Potatoes.....do....	5,502,000	140	39,300	79	4,346,580

Table showing the product of each principal crop, &c., for 1880—Continued.

Products.	Quantity produced in 1880.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
CALIFORNIA—Continued.					
Tobacco ....pounds..	....	....	....	....	....
Hay........tons..	1,257,558	1.80	698,643	$12 72	$15,906,138
Total........	....	....	3,526,202	....	65,014,410
OREGON.					
Indian corn........bushels..	113,005	23.3	4,850	82	92,664
Wheat........do....	11,734,420	17	690,260	78	9,152,848
Rye........do....	18,420	20	921	82	15,104
Oats........do....	4,754,662	31.2	152,393	40	1,901,865
Barley........do....	676,830	23.1	29,300	67	453,476
Buckwheat........do....	....	....	....	....	....
Potatoes........do....	925,940	134	6,910	59	546,303
Tobacco........pounds..	....	....	....	....	....
Hay........tons..	182,476	1.92	95,040	12 14	2,215,259
Total........	....	....	979,674	....	14,377,521
NEVADA.					
Indian corn........bushels..	9,740	20	487	80	7,792
Wheat........do....	47,600	17	2,800	95	45,220
Rye........do....	....	....	....	....	....
Oats........do....	148,400	28	5,300	65	96,460
Barley........do....	406,000	20	20,300	90	365,400
Buckwheat........do....	....	....	....	....	....
Potatoes........do....	259,500	150	1,730	1 25	324,375
Tobacco........pounds..	....	....	....	....	....
Hay........tons..	69,120	1.75	39,497	17 00	1,175,040
Total........	....	....	70,114	....	2,014,287
COLORADO.					
Indian corn........bushels..	255,207	18.5	13,795	77	196,509
Wheat........do....	1,110,100	17	65,300	95	1,054,595
Rye........do....	25,500	17	1,500	67	17,085
Oats........do....	648,000	27	24,000	65	421,200
Barley........do....	89,300	19	4,700	90	80,370
Buckwheat........do....	....	....	....	....	....
Potatoes........do....	75,440	46	1,640	1 10	82,984
Tobacco........pounds..	....	....	....	....	....
Hay........tons..	41,472	.94	44,119	25 62	1,062,513
Total........	....	....	155,054	....	2,915,256
TERRITORIES.					
Indian corn........bushels..	5,010,000	30	167,000	72	3,607,200
Wheat........do....	10,000,000	16	625,000	90	9,000,000
Rye........do....	88,000	16	5,500	67	58,960
Oats........do....	6,450,000	30	215,000	50	3,225,000
Barley........do....	1,340,000	20	67,000	79	1,058,600
Potatoes........do....	1,089,450	135	8,070	71	773,509
Tobacco........pounds..	2,850,000	750	3,800	07	199,500
Hay........tons..	198,816	1.79	111,070	11 70	2,326,147
Cotton........bales..	32,494,000	220	147,700	09	2,924,460
Total........	....	....	1,350,140	....	23,173,376

Summary for each State showing the product, the area, and the value of each crop for 1880.

STATES.	CORN.			WHEAT.			RYE.		
	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.
Maine	1, 102, 020	31, 300	$853, 175	531, 204	44, 267	$780, 870	39, 382	2, 574	$37, 807
New Hampshire	1, 401, 820	36, 890	1, 023, 329	158, 200	11, 300	221, 480	48, 960	3, 060	46, 512
Vermont	1, 801, 600	56, 300	1, 279, 136	314, 325	20, 955	418, 052	102, 456	5, 692	86, 063
Massachusetts	1, 875, 330	55, 980	1, 406, 497	18, 921	1, 113	24, 597	431, 550	24, 660	397, 026
Rhode Island	363, 180	12, 106	326, 862				27, 555	1, 837	27, 555
Connecticut	1, 621, 100	55, 900	1, 215, 825	39, 582	2, 199	55, 415	442, 380	30, 300	384, 871
New York	27, 895, 680	801, 600	15, 900, 538	12, 609, 200	788, 075	14, 752, 764	3, 611, 471	230, 630	2, 997, 521
New Jersey	14, 235, 200	347, 200	8, 256, 416	2, 460, 563	158, 746	2, 878, 859	1, 297, 362	97, 546	1, 167, 626
Pennsylvania	55, 804, 700	1, 874, 500	29, 576, 491	22, 114, 380	1, 474, 292	24, 104, 674	5, 857, 425	390, 495	4, 451, 643
Delaware	6, 467, 840	202, 120	3, 233, 920	1, 509, 785	98, 038	1, 736, 253	8, 889	773	6, 489
Maryland	21, 702, 080	678, 190	10, 634, 019	8, 486, 380	606, 170	9, 674, 473	364, 820	28, 954	313, 745
Virginia	45, 230, 600	1, 809, 200	18, 996, 600	8, 737, 302	919, 716	9, 174, 167	366, 400	45, 800	249, 152
North Carolina	36, 954, 120	2, 253, 300	19, 216, 142	4, 871, 213	761, 127	5, 601, 895	475, 664	59, 458	351, 991
South Carolina	11, 745, 900	1, 263, 000	9, 044, 343	869, 530	181, 152	1, 252, 123	32, 800	6, 560	41, 656
Georgia	21, 939, 240	2, 384, 700	15, 138, 076	3, 055, 374	484, 980	4, 155, 309	156, 702	26, 117	192, 743
Florida	3, 522, 180	374, 700	2, 993, 853						
Alabama	22, 679, 352	1, 828, 980	15, 195, 166	1, 402, 218	259, 670	1, 696, 684	32, 906	5, 773	34, 222
Mississippi	23, 218, 380	1, 590, 300	14, 627, 579	281, 166	41, 348	362, 704			
Louisiana	14, 912, 720	784, 880	9, 096, 759						
Texas	66, 754, 500	2, 670, 180	35, 379, 885	3, 008, 112	376, 014	3, 158, 518	40, 482	3, 114	36, 434
Arkansas	32, 350, 250	1, 294, 010	15, 851, 622	1, 356, 068	193, 724	1, 383, 189	29, 520	2, 866	25, 387
Tennessee	62, 469, 792	2, 788, 830	22, 489, 125	7, 538, 400	1, 256, 400	7, 387, 632	257, 091	30, 246	187, 676
West Virginia	17, 307, 000	576, 900	8, 134, 290	5, 130, 991	420, 573	4, 669, 202	189, 103	16, 588	130, 481
Kentucky	86, 039, 970	2, 956, 700	32, 695, 189	10, 564, 932	1, 214, 360	9, 825, 387	867, 295	78, 845	711, 182
Ohio	119, 940, 000	3, 198, 400	49, 175, 400	49, 790, 475	2, 845, 170	50, 780, 284	435, 120	29, 600	321, 989
Michigan	34, 816, 001	855, 430	16, 015, 360	33, 155, 865	1, 950, 345	32, 161, 189	290, 906	20, 779	209, 725
Indiana	99, 229, 300	3, 421, 700	39, 691, 720	49, 766, 758	2, 962, 307	49, 269, 090	304, 038	22, 860	212, 827
Illinois	240, 452, 896	8, 840, 180	86, 563, 043	60, 958, 757	3, 650, 225	57, 910, 819	3, 049, 860	184, 840	2, 226, 398
Wisconsin	33, 767, 382	1, 023, 254	12, 169, 279	16, 654, 735	1, 753, 130	16, 654, 735	2, 329, 470	162, 900	1, 584, 040
Minnesota	15, 478, 050	442, 230	5, 572, 098	40, 395, 696	3, 060, 280	35, 144, 256	201, 000	13, 400	116, 580
Iowa	260, 192, 840	6, 847, 180	67, 650, 138	33, 178, 205	3, 190, 212	27, 206, 128	1, 379, 932	102, 980	855, 558
Missouri	160, 463, 408	5, 650, 120	57, 766, 827	29, 583, 134	2, 206, 204	26, 311, 189	532, 980	42, 300	351, 767
Kansas	106, 218, 360	3, 625, 200	30, 803, 324	20, 336, 000	2, 033, 600	14, 235, 200	513, 366	37, 472	251, 549
Nebraska	59, 507, 600	1, 919, 600	14, 876, 900	12, 922, 677	1, 520, 315	9, 433, 554	385, 820	32, 110	219, 632
California	2, 580, 800	80, 650	1, 961, 408	33, 877, 600	2, 117, 350	32, 522, 496	306, 704	19, 169	254, 564
Oregon	113, 005	4, 850	92, 664	11, 734, 420	690, 260	9, 152, 848	18, 420	921	15, 104
Nevada	9, 740	487	7, 792	47, 600	2, 800	45, 220			
Colorado	255, 207	13, 795	196, 569	1, 110, 100	65, 300	1, 054, 595	25, 500	1, 500	17, 085
Territories	5, 010, 000	167, 000	3, 607, 200	10, 000, 000	625, 000	9, 000, 000	88, 000	5, 500	58, 960
Total	1, 717, 434, 543	62, 317, 842	679, 714, 499	498, 549, 868	37, 986, 717	474, 201, 850	24, 540, 829	1, 767, 619	18, 564, 560

Summary for each State showing the product, the area, and the value of each crop for 1880—Continued.

STATES.	OATS.			BARLEY.			BUCKWHEAT.		
	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.
Maine	2, 012, 825	80, 513	$966, 156	238, 779	11, 106	$188, 635	480, 000	19, 200	$240, 000
New Hampshire	891, 840	29, 728	428, 083	90, 500	3, 563	71, 495	102, 156	4, 581	66, 401
Vermont	3, 185, 536	99, 548	1, 433, 491	306, 574	10, 833	229, 930	348, 4[illegible]0	17, 420	202, 072
Massachusetts	717, 309	23, 139	380, 174	73, 282	3, 331	64, 488	104, 240	5, 212	62, 544
Rhode Island	167, 250	5, 575	88, 642						
Connecticut	1, 038, 355	36, 691	550, 328				162, 313	11, 194	100, 634
New York	40, 004, 318	1, 311, 617	17, 601, 900	8, 246, 745	352, 425	6, 844, 798	5, 135, 652	285, 314	2, 721, 896
New Jersey	3, 523, 500	130, 500	1, 444, 625				562, 240	32, 128	359, 834
Pennsylvania	35, 721, 420	1, 190, 714	13, 216, 925	499, 776	20, 824	419, 812	4, 109, 291	241, 723	2, 547, 760
Delaware	312, 930	17, 100	118, 913						
Maryland	2, 278, 320	94, 930	865, 762				190, 530	9, 872	127, 655
Virginia	5, 774, 780	524, 980	2, 367, 660				306, 577	16, 221	199, 275
North Carolina	5, 515, 400	501, 400	2, 812, 854				86, 976	5, 436	46, 967
South Carolina	3, 6[illegible]8, 020	263, 430	2, 618, 494						
Georgia	6, 184, 700	618, 470	4, 638, 525	22, 290	1, 486	13, 820			
Florida	436, 050	45, 900	414, 247						
Alabama	2, 9[illegible]6, 336	318, 080	2, 136, 225						
Mississippi	3, 021, 000	201, 400	1, 993, 860						
Louisiana	405, 000	27, 000	234, 900						
Texas	6, 9[illegible]6, 540	266, 790	3, 190, 808	140, 760	5, 760	100, 339			
Arkansas	2, 748, 834	152, 713	1, 456, 882						
Tennessee	5, 848, 570	449, [illegible]90	2, 339, 428	38, 565	2, 571	23, 910	75, 440	4, 600	47, 527
West Virginia	2, 411, 600	120, 580	795, 828				524, 388	29, 460	298, 901
Kentucky	7, 026, 120	390, 340	2, 599, 664	430, 000	20, 000	352, 600			
Ohio	25, 519, 200	911, 400	8, 676, 528	1, 420, 989	54, 030	1, 108, 371	380, 311	20, 782	273, 824
Michigan	16, 415, 100	547, 170	5, 745, 285	1, 388, 240	49, 580	1, 013, 415	624, 160	33, 200	380, 738
Indiana	15, 710, 978	636, 072	5, 184, 623	410, 000	16, 400	3[illegible]2, 100	106, 110	7, 860	82, 766
Illinois	62, 946, 510	1, 979, 450	18, 254, 488	1, 109, 425	49, 750	776, 597	259, 840	16, 240	213, 069
Wisconsin	30, 895, 528	983, 934	12, 049, 256	4, 903, 750	196, 150	3, 040, 325	584, 309	33, 581	362, 272
Minnesota	21, 069, 425	648, 290	6, 110, 133	3, 163, 860	117, 180	1, 835, 039	66, 130	3, 890	44, 307
Iowa	49, 922, 400	1, 512, 800	11, 482, 152	3, 887, 148	171, 240	2, 021, 317	238, 143	14, 610	173, 844
Missouri	25, 314, 304	988, 840	7, 341, 148	96, 104	5, 860	72, 078	83, 742	4, 926	51, 088
Kansas	8, 582, 520	386, 600	2, 746, 406	27[illegible], 504	19, 890	146, 072	41, 747	2, 372	39, 242
Nebraska	5, 284, 700	245, 800	1, 374, 022	1, 186, 680	89, 900	498, 406	27, 160	1, 940	26, 617
California	1, 447, 100	49, 900	940, 615	14, 720, 245	520, 150	8, 979, 349	17, 680	1, 040	13, 260
Oregon	4, 754, 662	152, 393	1, 901, 865	676, 830	29, 300	453, 476			
Nevada	148, 400	5, 300	96, 460	406, 000	20, 300	365, 400			
Colorado	648, 000	24, 000	421, 200	89, 300	4, 700	80, 370			
Territories	6, 450, 000	215, 000	3, 225, 600	1, 340, 000	67, 000	1, 058, 600			
Total	417, 885, 380	16, 187, 977	150, 243, 565	45, 165, 346	1, 843, 329	30, 090, 742	14, 617, 535	822, 802	8, 682, 488

Summary for each State showing the product, the area, and the value of each crop for 1880—Continued.

STATES.	POTATOES.			TOBACCO.			HAY.			COTTON.		
	Bushels.	Acres.	Value.	Pounds.	Acres.	Value.	Tons.	Acres.	Value.	Pounds.	Acres.	Value.
Maine	5,154,190	48,170	$2,474,011				1,297,296	1,284,451	$16,436,740			
New Hampshire	3,786,300	36,060	1,665,972				592,764	658,627	7,925,255			
Vermont	4,954,740	35,140	2,080,991				1,182,030	1,094,472	12,293,112			
Massachusetts	5,244,120	41,620	2,674,501	4,927,840	3,242	$739,176	863,691	799,714	15,831,456			
Rhode Island	444,000	5,920	266,400				108,015	144,020	1,728,240			
Connecticut	2,795,310	32,130	1,677,186	15,487,660	10,070	2,323,149	760,550	760,550	12,168,800			
New York	32,571,900	361,910	13,680,198	6,572,800	5,135	788,736	5,047,920	4,853,769	80,261,928			
New Jersey	4,239,280	55,780	2,373,997				489,214	494,156	9,353,772			
Pennsylvania	13,436,320	170,080	6,449,434	34,854,108	29,739	3,485,411	2,727,360	2,548,935	44,728,704			
Delaware	308,000	4,400	175,560				26,642	32,099	488,348			
Maryland	855,920	16,460	479,315	18,841,830	26,726	1,318,928	174,666	205,489	2,978,055			
Virginia	1,394,350	17,650	641,401	78,421,860	118,821	6,273,749	169,323	130,248	2,213,052			
North Carolina	1,272,600	12,120	852,642	35,724,385	63,229	3,215,195	113,664	74,290	1,199,155	184,734,000	933,000	$18,473,400
South Carolina	90,850	1,150	78,131				20,412	15,120	376,601	266,696,000	1,441,600	29,336,560
Georgia	441,600	4,800	485,760				34,650	18,431	554,400	454,166,900	2,786,300	45,416,690
Florida										35,727,200	251,600	3,215,448
Alabama	370,510	4,690	285,293				34,900	21,280	518,963	378,932,400	2,460,600	37,893,240
Mississippi	404,000	4,040	359,560				28,288	17,570	393,203	391,300,000	2,275,000	39,130,000
Louisiana										161,616,000	888,000	16,161,600
Texas	753,460	7,460	858,944				196,500	101,813	1,768,500	550,873,000	2,395,100	49,578,570
Arkansas	976,720	8,420	722,773				21,364	14,435	245,686	232,243,000	1,080,200	23,224,300
Tennessee	1,174,250	15,250	587,125	24,319,890	38,603	2,188,790	165,842	109,829	2,139,362	165,688,600	816,200	14,911,974
West Virginia	915,000	12,200	411,750	2,898,552	4,071	318,841	234,320	207,363	2,563,461			
Kentucky	1,716,000	26,400	840,840	149,017,855	224,087	10,431,250	265,226	176,811	3,262,280			
Ohio	10,574,000	124,400	5,075,520	38,434,587	35,489	2,306,075	2,210,400	1,782,581	26,878,464			
Michigan	10,897,600	97,300	4,468,016				800,712	563,882	9,848,758			
Indiana	3,469,200	58,800	2,046,828	7,609,030	10,642	380,451	1,481,760	1,001,189	15,262,128			
Illinois	11,193,750	149,250	6,156,562	3,012,948	5,574	195,647	2,595,530	1,790,021	21,672,675			
Wisconsin	13,552,110	136,890	4,743,238	11,395,824	9,168	1,367,499	982,080	738,406	9,820,800			
Minnesota	4,880,040	36,970	1,659,214				1,577,702	871,659	9,466,212			
Iowa	10,241,950	107,810	3,789,521				2,851,200	2,007,887	17,192,736			
Missouri	6,621,720	78,830	3,112,208	11,027,720	14,120	882,218	1,147,770	819,836	10,605,395			
Kansas	3,990,700	57,010	3,152,653				1,409,436	1,127,549	6,821,670			
Nebraska	1,086,750	15,750	662,917				564,564	409,104	2,038,076			
California	5,502,000	39,300	4,346,580				1,257,558	698,643	15,996,138			
Oregon	925,940	6,910	546,305				182,476	95,040	2,215,259			
Nevada	259,500	1,730	324,375				69,120	39,497	1,175,040			
Colorado	75,440	1,640	82,984				41,472	44,119	1,062,513			
Territories	1,089,450	8,070	773,509	*$2,850,000	3,600	199,500	198,816	111,070	2,326,147	†32,494,000	147,700	2,924,460
Total	167,659,570	1,842,510	81,062,214	446,296,889	602,516	36,414,615	31,925,233	25,863,955	371,811,084	‡2,854,471,100	15,475,300	280,266,242

* This amount includes an aggregate estimate of the tobacco crop of States left blank in the column above.

† Produced chiefly in Indian Territory.

‡ 6,343,269 bales of 450 pounds each.

Table showing the average yield per acre and the price per bushel, pound, or ton, of farm products for the year 1880.

STATES.	CORN.		WHEAT.		RYE.		OATS.		BARLEY.		BUCKWHEAT.		POTATOES.		TOBACCO.		HAY.		COTTON.	
	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Pounds.	Price per pound.	Tons.	Price per ton.	Pounds.	Price per pound.
Maine	35.4	$0 77	12	$1 47	15.3	$0 96	25	$0 48	21.5	$0 79	25	$0 50	107	$0 48	......	......	1.01	$12 67	......	......
New Hampshire	38	73	14	1 40	16	95	30	48	25.4	79	22.3	65	105	44	......	......	.90	13 37	......	......
Vermont	32	71	15	1 33	18	84	32	45	28.3	75	20	58	141	42	......	......	1.08	10 40	......	......
Massachusetts	33.5	75	17	1 30	17.5	92	31	53	22	88	20	60	126	51	1,520	$0 15	1.08	18 33	......	......
Rhode Island	30	90	......	......	15	1 00	30	53	......	......			75	60	......	......	.75	16 00	......	......
Connecticut	29	75	18	1 40	14.6	87	28.3	53	......	......	14.5	62	87	60	1,538	15	1	16 00	......	......
New York	34.8	57	16	1 17	15.7	83	30.5	44	23.4	83	18	53	90	42	1,280	12	1.04	15 90	......	......
New Jersey	41	58	15.5	1 17	13.3	90	27	41	......	......	17.5	64	76	56	......	......	.99	19 12	......	......
Pennsylvania	40.6	53	15	1 09	15	76	30	37	24	84	17	62	79	48	1,172	10	1.07	16 40	......	......
Delaware	32	50	15.4	1 15	11.5	73	18.3	38	......	......	......	......	70	57	......	......	.83	18 33	......	......
Maryland	32	49	14	1 14	12.6	86	24	38	......	......	19.3	67	52	56	705	7	.85	17 05	......	......
Virginia	25	42	9.5	1 05	8	68	11	41	......	......	18.9	65	79	46	660	8	1.30	13 07	......	......
North Carolina	16.4	52	6.4	1 15	8	74	11	51	......	......	16	54	105	67	565	9	1.53	10 55	198	$0 10
South Carolina	9.3	77	4.8	1 44	5	1 27	14	71	......	......	......	......	79	86	......	......	1.35	18 45	185	11
Georgia	9.2	69	6.3	1 36	6	1 23	10	75	15	62	......	......	92	110	......	......	1.88	16 00	163	10
Florida	9.4	85	......	......	......	......	9.5	95	......	......	......	......			......	......	......	......	142	9
Alabama	12.4	67	5.4	1 21	5.7	1 04	9.2	73	......	......	......	......	79	77	......	......	1.64	14 87	154	10
Mississippi	14.6	63	6.8	1 29	......	......	15	66	......	......	......	......	100	89	......	......	1.61	13 90	172	10
Louisiana	19	61	......	......	......	......	15	58	......	......	......	......			......	......	......	......	182	10
Texas	25	53	8	1 05	13	90	26	46	26	67	......	......	101	1 14	......	......	1.93	9 00	230	9
Arkansas	25	49	7	1 02	10.3	86	18	53	......	......			116	74	......	......	1.48	11 50	215	10
Tennessee	22.4	36	6	98	8.5	73	13	40	15	62	16.4	63	77	50	630	9	1.51	12 90	203	9
West Virginia	30	47	12.2	91	11.4	69	20	33	......	......	17.8	57	75	45	712	11	1.13	10 94	......	......
Kentucky	29.1	38	8.7	93	11	82	18	37	21.5	82	......	......	65	49	665	7	1.50	12 30	......	......
Ohio	37.5	41	17.5	1 02	14.7	74	28	34	26.3	78	18.3	72	85	48	1,083	6	1.24	12 16	......	......
Michigan	40.7	46	17	97	14	69	30	35	28	73	18.8	61	112	41	......	......	1.42	12 30	......	......
Indiana	29	40	16.8	99	13.3	70	24.7	33	25	81	13.5	78	59	59	715	5	1.48	10 30	......	......
Illinois	27.2	36	16.7	95	16.5	73	31.8	29	22.3	70	16	82	75	55	702	5	1.45	8 35	......	......
Wisconsin	33	39	9.5	1 00	14.3	68	31.4	30	25	62	17.4	62	99	35	1,243	12	1.33	10 00	......	......
Minnesota	35	36	13.2	87	15	58	32.5	29	27	58	17	67	132	34	......	......	1.81	6 00	......	......
Iowa	38	26	10.4	82	13.4	62	33	23	22.7	52	16.3	73	95	37	......	......	1.42	6 03	......	......
Missouri	28.4	36	13.4	89	12.6	66	25.6	29	16.4	75	17	61	84	47	781	8	1.40	9 24	......	......
Kansas	29.3	29	10	70	13.7	49	22.2	32	13.6	54	17.6	94	70	79	......	......	1.25	4 84	......	......
Nebraska	31	25	8.5	73	12	57	21.5	26	13.2	42	14	98	69	61	......	......	1.38	3 61	......	......
California	32	76	16	96	16	83	29	65	28.3	61	17	75	140	79	......	......	1.80	12 72	......	......
Oregon	23.3	82	17	78	20	82	31.2	40	23.1	67			134	59	......	......	1.92	12 14	......	......
Nevada	20	80	17	95	......	......	28	65	20	90	......	......	150	1 25	......	......	1.75	17 00	......	......
Colorado	18.5	77	17	95	17	67	27	65	19	90	......	......	46	1 10	......	......	.94	25 62	......	......
Territories	30	72	16	90	16	67	30	50	20	79	......	......	135	71	750	7	1.79	11 70	220	9

Table showing the average cash value per acre of farm products for the year 1880.

STATES.	Corn.	Wheat.	Rye.	Oats.	Barley.	Buckwheat.	Potatoes.	Tobacco.	Hay.	Cotton.
Maine	$27 26	$17 64	$14 69	$12 00	$16 98	$12 50	$51 36	....	$12 80	....
New Hampshire	27 74	19 60	15 20	14 40	20 07	14 49	46 20	....	12 03	....
Vermont	22 72	19 95	15 12	14 40	21 22	11 60	59 22	....	11 23	....
Massachusetts	25 12	22 10	16 10	16 43	19 36	12 00	64 26	$228 00	19 80	....
Rhode Island	27 00	....	15 00	15 90	....	....	45 00	....	12 00	....
Connecticut	21 75	25 20	12 70	15 00	....	8 99	52 20	230 70	16 00	....
New York	19 84	18 72	13 03	13 42	19 42	9 54	37 80	153 60	16 54	....
New Jersey	23 78	18 13	11 97	11 07	....	11 20	42 56	....	18 93	....
Pennsylvania	21 52	16 35	11 40	11 10	20 16	10 54	37 92	117 20	17 55	....
Delaware	16 00	17 71	8 39	6 95	....	....	39 90	....	15 21	....
Maryland	15 68	15 96	10 84	9 12	....	12 93	29 12	49 35	14 49	....
Virginia	10 50	9 97	5 44	4 51	....	12 28	36 34	52 80	16 99	....
North Carolina	8 53	7 36	5 92	5 61	....	8 64	70 35	50 85	16 14	$19 80
South Carolina	7 16	6 91	6 35	9 94	....	....	67 94	....	24 91	20 35
Georgia	6 35	8 57	7 38	7 50	9 30	....	101 20	....	30 08	16 30
Florida	7 99	....	....	9 02	....	....	....	....	....	12 78
Alabama	8 31	6 53	5 93	6 72	....	....	60 83	....	24 39	15 40
Mississippi	9 20	8 77	....	9 90	....	....	89 00	....	22 38	17 20
Louisiana	11 59	....	....	8 70	....	....	....	....	....	18 20
Texas	13 25	8 40	11 70	11 96	17 42	....	115 14	....	17 37	20 70
Arkansas	12 25	7 14	8 86	9 54	....	....	85 84	....	17 02	21 50
Tennessee	8 06	5 88	6 20	5 20	9 30	10 33	38 50	56 70	19 48	18 27
West Virginia	14 10	11 10	7 87	6 60	....	10 15	33 75	78 32	12 36	....
Kentucky	11 06	8 09	9 02	6 66	17 63	....	31 85	46 55	18 45	....
Ohio	15 37	17 85	10 88	9 52	20 51	13 18	40 80	64 98	15 08	....
Michigan	18 72	16 49	9 66	10 50	20 44	11 47	45 92	....	17 47	....
Indiana	11 60	16 63	9 31	8 15	20 25	10 53	34 81	35 75	15 24	....
Illinois	9 79	15 86	12 04	9 22	15 61	13 12	41 25	35 10	12 11	....
Wisconsin	12 87	9 50	9 72	12 25	15 50	10 79	34 65	149 16	13 30	....
Minnesota	12 69	11 48	8 70	9 42	15 66	11 39	44 88	......	10 86	....
Iowa	9 88	8 53	8 31	7 59	11 80	11 90	35 15	.....	8 56	....
Missouri	10 22	11 93	8 32	7 42	12 30	10 37	39 48	62 48	12 94	....
Kansas	8 50	7 00	6 71	7 10	7 34	16 54	55 30	......	6 05	....
Nebraska	7 75	6 20	6 84	5 50	5 54	13 72	42 09	......	4 98	....
California	24 32	15 36	12 28	18 85	17 26	12 75	110 60	....	22 90	....
Oregon	19 11	13 26	16 40	12 48	15 48	......	79 06	......	23 31	....
Nevada	16 00	16 15	....	18 20	18 00	......	187 50	......	29 75	....
Colorado	14 24	16 15	11 39	17 55	17 10		50 60	....	24 08	....
Territories	21 60	14 40	10 72	15 00	15 80	...	95 85	52 50	20 94	19 80

Table showing the average cash value per acre of the principal crops of the farm, taken together, for the year 1880.

States.	Average value per acre.	States.	Average value per acre.
Maine	$14 44	Arkansas	$15 62
New Hampshire	11 61	Tennessee	9 50
Vermont	13 45	West Virginia	12 48
Massachusetts	22 53	Kentucky	11 93
Rhode Island	14 39	Ohio	16 60
Connecticut	19 68	Michigan	16 96
New York	17 30	Indiana	13 82
New Jersey	19 63	Illinois	11 64
Pennsylvania	17 33	Wisconsin	12 46
Delaware	16 25	Minnesota	11 54
Maryland	15 83	Iowa	9 34
Virginia	11 20	Missouri	10 85
North Carolina	11 10	Kansas	7 98
South Carolina	13 48	Nebraska	6 88
Georgia	11 16	California	18 44
Florida	9 85	Oregon	14 68
Alabama	11 79	Nevada	28 73
Mississippi	13 77	Colorado	18 80
Louisiana	22 52	Territories	17 16
Texas	16 15		

A general summary showing the estimated quantities, number of acres, and aggregate value of the principal crops of the farm in 1880.

Products.	Number of bushels, &c.	Number of acres.	Value.
Indian corn .... bushels..	1,717,434,543	62,317,842	$679,714,499
Wheat .... do...	498,549,868	37,986,717	474,201,850
Rye .... do...	24,540,829	1,767,619	18,564,560
Oats .... do...	417,885,380	16,187,977	150,243,565
Barley .... do...	45,165,346	1,843,329	30,090,742
Buckwheat .... do...	14,617,535	822,802	8,682,488
Potatoes .... do...	167,659,570	1,842,510	81,062,214
Total	2,885,853,071	122,768,796	1,442,559,918
Tobacco .... pounds...	446,296,889	602,516	36,414,615
Hay .... tons...	31,925,233	25,863,955	371,811,084
Cotton .... bales...	6,343,269	15,475,300	280,266,242
Grand total	....	164,710,567	2,131,051,859

Table showing the average yield and cash value per acre, and price per bushel, pound, or ton, of farm products for the year 1880.

Products.	Average yield per acre.	Average price per bushel.	Average value per acre.	Products.	Average yield per acre.	Average price per bushel, pound, or ton.	Average value per acre.
Indian corn ... bush..	27.6—	$0 39.6—	$10 91	Buckwheat ... bush.	17.7 +	$0 59.4 —	$10 55
Wheat .... do...	13.1+	0 95.1+	12 48	Potatoes .... do..	91.0 —	0 48.3 +	44 00
Rye .... do...	13.9—	0 75.6+	10 50	Tobacco .... pounds.	740.7 +	0 08.2 —	60 44
Oats .... do...	25.8+	0 36.0—	9 28	Hay .... tons	1.23+	11.65—	14 38
Barley .... do...	24.5+	0 66.6+	16 32	Cotton ...... pounds.	184.5 —	0 09.8 +	18 11

CONDITION OF FARM ANIMALS.

The condition of farm animals for the year 1880 has been exceptionally favorable. The winter of 1879–'80 was unusually mild, to which was added a very prosperous and bountiful harvest the fall previous, so that the stock of the country came out of winter quarters in a remarkably good condition. The usual complaints of local diseases, such as lung and throat diseases among horses, foot-rot, scab, and grub in the head among sheep, and measles, quinsy, and cholera among swine, were reported in divers sections, but, taken as a whole, the condition was better than since several years. During the summer and fall in a few localities diseases of cattle were mentioned, and the usual complaint of cholera among swine, but generally the reports of the latter disease were coupled with the remark that it was not so prevalent as in former years, and the opinion of many reporting the disease was that it was chiefly caused by overcrowding and lack of attention to food, water, and general cleanliness.

The estimate of numbers shows a large increase since the estimate made a year since, and it is to be regretted that the enumeration made of all live stock by the census in June is not available at this date, as it is believed that the increase, particularly in sheep and swine, has been greater than has been reported to us by our correspondents.

Table showing the estimated total number and total value of each kind of live stock, and the average price in December, 1880.

STATES.	HORSES.			MULES.			MILCH COWS.		
	Number.	Average price.	Value.	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	81,700	$65 79	$5,375,043				157,388	$23 21	$3,652,975
New Hampshire	57,100	59 76	3,412,296				98,100	26 25	2,575,125
Vermont	77,400	61 35	4,748,490				200,887	24 30	4,881,554
Massachusetts	149,820	78 96	11,829,787				173,784	35 00	6,082,440
Rhode Island	16,200	94 50	1,530,900				22,000	30 00	660,000
Connecticut	54,000	57 07	3,081,780				118,800	28 37	3,370,356
New York	907,889	73 64	66,856,946	11,564	$86 39	$999,014	1,431,700	26 66	38,169,122
New Jersey	114,500	95 67	10,954,215	13,563	124 32	1,686,152	153,700	33 80	5,195,060
Pennsylvania	602,200	72 70	43,779,940	22,453	84 48	1,896,829	828,333	26 24	21,735,458
Delaware	20,706	82 25	1,703,068	4,080	98 62	402,370	25,048	23 00	576,104
Maryland	108,600	69 00	7,493,410	11,413	103 72	1,183,756	98,605	29 82	2,940,401
Virginia	227,803	59 68	13,595,283	31,612	71 43	2,258,045	243,006	19 25	4,677,865
North Carolina	146,700	67 31	9,874,377	74,700	74 64	5,575,608	230,000	13 46	3,095,800
South Carolina	64,480	83 05	5,355,064	57,240	94 52	5,410,325	133,926	16 42	2,199,065
Georgia	121,584	71 98	8,751,616	99,182	90 08	8,934,315	273,100	14 73	4,022,763
Florida	23,644	65 21	1,541,825	12,257	74 94	918,540	65,520	12 21	799,999
Alabama	115,039	59 23	6,813,760	118,553	65 85	7,806,715	215,127	13 93	2,996,719
Mississippi	101,082	72 77	7,355,737	109,200	87 46	9,550,632	200,235	15 48	3,099,638
Louisiana	82,500	57 29	4,726,425	80,700	86 55	6,984,585	115,200	17 78	2,048,256
Texas	1,002,456	26 80	26,865,821	202,460	44 66	9,041,864	566,300	14 15	8,013,145
Arkansas	191,100	49 36	9,432,696	97,445	66 84	6,513,224	206,960	14 56	3,013,338
Tennessee	320,362	53 98	17,293,141	96,700	65 31	6,315,477	255,543	17 15	4,382,562
West Virginia	127,092	52 66	6,692,665	2,425	56 35	136,649	133,118	22 34	2,973,856
Kentucky	393,376	53 08	21,145,798	87,544	61 49	5,383,081	270,000	25 58	6,906,600
Ohio	795,074	57 80	45,955,277	22,568	66 04	1,490,391	693,000	27 63	19,147,590
Michigan	354,005	79 21	28,040,738	4,576	95 92	438,930	416,900	28 69	11,960,861
Indiana	702,576	54 77	38,480,088	54,664	62 70	3,427,433	439,148	24 49	10,754,735
Illinois	1,067,220	58 55	62,485,731	124,527	67 73	8,434,214	709,308	27 71	19,654,925
Wisconsin	399,942	63 63	25,448,309	8,989	77 44	696,108	439,872	20 71	9,109,749
Minnesota	285,480	69 91	19,957,907	7,528	95 12	716,063	316,160	22 86	7,227,418
Iowa	809,536	63 65	51,526,966	45,594	79 19	3,610,589	782,460	26 70	20,891,682
Missouri	646,198	47 16	30,474,698	184,224	57 27	10,550,508	542,295	20 25	10,981,474
Kansas	326,673	48 96	15,997,177	58,710	63 65	3,736,892	375,998	26 48	9,956,427
Nebraska	188,427	67 39	12,698,096	16,568	90 33	1,496,587	157,190	26 77	4,207,976
California	281,990	45 03	12,698,010	25,700	68 79	1,767,903	473,400	31 67	14,992,578
Oregon	120,922	56 22	6,798,235	3,528	60 31	212,774	125,042	21 17	2,647,139
Nevada, Colorado, and the Territories	339,250	50 65	17,183,012	30,464	82 74	2,520,591	681,500	24 47	16,676,305
Total	11,429,626		667,954,325	1,720,731		120,096,164	12,368,653		296,277,060
Grand average of prices		58 44			69 79			23 95	

Table showing the estimated total number and total value of each kind of live stock, &c.—Continued.

STATES.	OXEN AND OTHER CATTLE.			SHEEP.			HOGS.		
	Number.	Average price.	Value.	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	199, 626	$22 86	$4, 568, 450	632, 078	$3 21	$2, 028, 970	57, 600	$8 81	$507, 456
New Hampshire	123, 725	31 24	3, 865, 169	246, 942	3 09	762, 951	45, 450	11 85	538, 582
Vermont	125, 235	21 53	2, 696, 310	508, 572	3 32	1, 688, 459	49, 400	8 23	406, 562
Massachusetts	116, 049	36 88	4, 279, 887	65, 199	2 29	149, 306	88, 290	13 42	1, 184, 852
Rhode Island	15, 700	30 05	471, 785	28, 200	3 70	104, 340	13, 800	8 70	120, 060
Connecticut	125, 600	30 38	3, 815, 728	98, 071	3 55	348, 152	60, 600	13 75	833, 250
New York	648, 542	23 13	15, 000, 776	2, 338, 148	3 57	8, 347, 188	964, 080	7 81	7, 529, 465
New Jersey	84, 500	29 17	2, 464, 865	129, 748	4 11	533, 264	220, 400	8 80	1, 939, 520
Pennsylvania	626, 525	23 45	14, 692, 011	1, 632, 807	3 27	5, 339, 279	909, 200	7 03	6, 391, 676
Delaware	32, 640	19 57	638, 765	38, 800	3 16	122, 608	47, 600	6 94	330, 344
Maryland	120, 400	17 89	2, 153, 956	152, 700	3 06	467, 262	264, 800	5 65	1, 496, 120
Virginia	431, 100	16 99	7, 324, 389	447, 405	2 68	1, 199, 045	950, 800	3 93	3, 736, 644
North Carolina	407, 484	8 77	3, 573, 635	385, 900	1 35	520, 965	1, 237, 300	3 20	3, 959, 360
South Carolina	175, 456	10 08	1, 768, 596	187, 090	1 79	334, 891	676, 640	3 36	2, 273, 510
Georgia	408, 816	7 98	3, 262, 352	378, 144	1 53	578, 560	1, 701, 640	2 96	5, 036, 854
Florida	539, 656	7 51	4, 052, 817	70, 083	1 85	129, 654	202, 954	2 06	418, 085
Alabama	265, 122	8 14	2, 158, 093	224, 910	1 67	375, 600	1, 184, 000	3 21	3, 800, 640
Mississippi	259, 875	8 75	2, 273, 906	202, 303	1 56	315, 593	1, 230, 800	3 25	4, 000, 100
Louisiana	118, 701	10 77	1, 278, 410	116, 994	1 64	191, 870	625, 400	4 06	2, 539, 124
Texas	4, 072, 240	10 15	41, 333, 236	6, 023, 628	2 05	12, 348, 437	2, 035, 900	3 13	6, 372, 367
Arkansas	378, 726	10 11	3, 828, 920	296, 435	1 48	438, 724	1, 580, 500	3 17	5, 010, 185
Tennessee	377, 530	11 76	4, 439, 753	858, 500	1 54	1, 322, 000	1, 623, 500	3 22	5, 227, 670
West Virginia	237, 354	20 16	4, 785, 057	660, 550	2 43	1, 605, 136	504, 300	3 63	1, 830, 509
Kentucky	419, 237	19 77	8, 288, 315	1, 020, 996	2 82	2, 879, 208	1, 739, 500	3 86	6, 714, 470
Ohio	776, 160	23 76	18, 441, 562	4, 243, 616	3 08	13, 070, 337	1, 963, 392	5 63	11, 053, 897
Michigan	393, 600	23 61	9, 294, 313	1, 930, 656	3 16	6, 100, 873	506, 437	5 83	2, 952, 528
Indiana	764, 166	19 03	14, 542, 079	1, 029, 570	2 72	2, 800, 430	2, 186, 000	5 23	11, 432, 780
Illinois	1, 222, 947	23 56	28, 812, 631	1, 155, 232	2 90	3, 350, 173	3, 202, 000	5 86	18, 763, 720
Wisconsin	517, 473	20 49	10, 603, 022	1, 329, 261	2 52	3, 349, 738	571, 800	5 28	3, 019, 104
Minnesota	328, 848	20 78	6, 833, 461	313, 650	2 56	802, 944	203, 900	5 76	1, 174, 464
Iowa	1, 411, 512	21 75	30, 700, 886	463, 488	2 90	1, 344, 115	2, 778, 400	5 97	16, 587, 048
Missouri	1, 697, 749	18 33	31, 119, 739	1, 619, 931	2 19	3, 547, 649	2, 620, 000	3 81	9, 982, 200
Kansas	667, 131	20 69	13, 802, 940	449, 999	2 64	1, 187, 997	1, 785, 000	6 07	10, 834, 950
Nebraska	505, 040	21 40	10, 807, 856	193, 536	2 75	532, 224	1, 320, 000	5 10	6, 732, 000
California	999, 900	20 35	20, 347, 965	7, 493, 864	1 70	12, 739, 569	667, 600	4 98	3, 324, 648
Oregon	199, 485	13 72	2, 736, 934	1, 176, 433	1 46	1, 717, 592	239 900	3 69	885, 331
Nevada, Colorado, and the Territories	1, 144, 800	19 05	21, 808, 440	5, 426, 460	2 10	11, 395, 566	188, 800	8 45	1, 595, 360
Total	20, 937, 702	....	362, 861, 509	43, 576, 899	....	104, 070, 759	36, 247, 603	....	170, 535, 435
Grand average of prices	....	17 33	....	....	2 39	....	....	4 70	....

FARM WAGES AND LABOR.

The following table of wages paid for labor in the farming districts of the United States was compiled from returns made in the month of March, 1881, and is placed in the report of this year. Apparently it should be in the report for 1881, but as the returns are made in the spring following the date of the report, and before the funds to print the report of that year are available, it is deemed best to place the facts before the public at as early a day as possible, and not wait till after the close of the year. The same explanation applies to the tables of labor and wages published in the reports of 1878 and 1879.

Average wages for 1881.

STATES AND TERRITORIES.	PER MONTH.		PER DAY.								
	By the year.		Transient in harvest.		Transient not in harvest.		Carpentering.	Blacksmithing.	Wheelwrighting.	Machine-making.	Shoe-making.
	Without board.	With board.	Without board.	With board.	Without board.	With board.	Without board.	Without board.	Without board.	Without board.	Without board.
Maine	$20 62	$12 80	$1 69	$1 20	$1 15	$0 81	$2 00	$1 00	$1 88	$2 15	$1 76
New Hampshire	20 36	13 00	1 43	1 07	1 18	86	2 03	1 86	1 87	2 04	1 48
Vermont	22 30	14 33	1 53	1 14	1 04	72	1 81	1 82	1 92	2 20	1 69
Massachusetts	25 33	15 44	1 62	1 25	1 33	97	2 04	2 21	2 21	2 30	1 81
Rhode Island	22 00	14 00	1 00	75	1 00	75	1 50	......	1 50	......	......
Connecticut	26 00	13 00	1 75	1 37	1 00	87	2 00	2 00	1 50	2 00	1 00
New York	22 13	13 81	1 74	1 33	1 08	76	2 06	1 59	2 15	2 10	1 71
New Jersey	22 30	12 80	1 82	1 40	1 05	74	2 01	1 92	2 00	2 06	1 73
Pennsylvania	22 47	13 80	1 47	1 18	1 05	75	1 78	1 70	1 67	1 93	1 46
Delaware	......	......	......	......	......	......	......	......	......	......	......
Maryland	16 31	10 10	1 37	1 09	78	49	1 73	1 61	1 75	2 18	1 58
Virginia	12 66	8 43	1 23	98	64	46	1 73	1 68	1 70	1 83	1 25
North Carolina	12 66	8 78	1 07	84	63	46	1 61	1 59	1 65	2 12	1 31
South Carolina	10 43	7 95	93	78	56	44	1 65	1 77	1 79	1 87	1 46
Georgia	12 46	8 47	1 08	86	66	47	1 89	1 86	2 05	2 28	1 61
Florida	15 73	9 26	1 00	76	80	55	2 02	2 01	2 01	2 43	1 85
Alabama	13 17	9 38	1 10	82	76	57	2 12	2 22	2 23	2 83	1 78
Mississippi	15 10	10 24	1 23	87	81	57	2 23	2 23	2 14	2 51	1 82
Lonisiana	17 46	12 26	1 19	88	89	64	2 31	2 53	2 66	2 75	2 03
Texas	19 11	13 31	1 32	97	95	68	2 31	2 36	2 33	3 10	2 20
Arkansas	19 30	13 03	1 47	1 12	1 03	75	2 26	2 36	2 28	2 67	1 97
Tennessee	15 15	9 58	1 33	1 08	73	53	1 83	1 74	1 93	2 38	1 45
West Virginia	17 82	11 71	1 18	87	76	55	1 76	1 71	1 59	2 06	1 41
Kentucky	16 61	11 19	1 42	1 11	78	55	1 88	1 80	1 92	2 22	1 64
Ohio	22 30	14 66	1 79	1 30	1 13	83	2 01	1 92	2 04	2 27	1 68
Michigan	24 50	16 58	2 24	1 75	1 21	87	2 07	1 98	2 40	2 31	1 81
Indiana	21 15	14 52	1 94	1 57	1 00	73	1 98	1 96	2 11	2 29	1 70
Illinois	23 53	16 25	1 94	1 59	1 17	88	2 20	2 08	2 19	2 37	1 80
Wisconsin	23 76	15 87	2 06	1 67	1 19	90	2 22	2 03	2 36	2 46	1 73
Minnesota	26 26	16 44	2 82	2 29	1 35	99	2 34	2 13	2 31	2 59	1 86
Iowa	24 36	16 38	2 10	1 69	1 18	92	2 21	2 13	2 05	2 34	1 85
Missouri	19 53	13 34	1 61	1 26	93	66	2 06	1 96	2 04	2 35	1 75
Kansas	22 49	14 06	1 63	1 22	1 06	74	1 86	2 04	2 09	2 37	1 82
Nebraska	24 44	14 53	2 01	1 51	1 21	87	2 22	2 21	2 40	2 58	1 98
California	38 00	25 67	2 21	1 77	1 76	1 21	3 28	3 19	3 29	3 69	2 61
Oregon	33 50	21 60	1 97	1 47	1 56	1 10	2 85	3 10	3 44	3 62	2 67
Nevada	......	35 00	2 00	1 67	1 50	1 37	4 33	4 33	5 00	5 50	3 50
Colorado	38 33	23 71	2 10	1 34	1 75	1 29	2 75	2 69	2 65	3 17	2 46
Utah	38 56	25 00	1 95	1 48	1 41	1 10	2 60	2 90	2 83	2 96	2 05
New Mexico	33 00	21 00	1 38	1 00	1 20	75	2 90	2 80	2 80	3 00	2 38
Washington	38 67	24 17	2 25	1 57	1 56	1 04	3 04	3 30	3 82	4 00	2 80
Dakota	30 18	19 55	2 53	2 15	1 42	1 27	2 72	3 00	2 96	3 58	2 00
Montana	45 00	30 50	2 67	2 25	1 83	1 38	4 00	3 62	4 19	4 12	3 25
Indian	24 50	14 33	2 00	1 33	1 00	58	2 50	2 75	2 50	......	2 00

A comparison of the returns in the first two columns of the above table, with similar returns made and published a year since, gives a clear idea of the changes in value of labor since then. The advance then noted, as the first reaction since the depression following 1873, has still progressed, and there is a decided increase in the wages of labor in nearly every section of the country.

The average wage of labor, as engaged by the month or year, and which represents the steady and reliable working force, is returned this year as being, without board, $22.39, against $21.75 last spring, and $20.26 in 1879, being an increase of 64 cents since a year, and $2.13 since two years. The average price for the same class of labor, with board, is $14.86, against $14.56 last year, and $13.12 in 1879. By taking the differences between the figures of the first and second columns in the above table, differences between wages with board and wages without board, there is apparent a very close estimate of the actual cost of subsisting the laborer in the different States. Taking the average of all these differences, we find the cost of subsistence to be this year $7.53, $7.19 in 1880, and $7.14 in 1879. The different sections of the Union present some interesting points of comparison. New England, as a whole, pays $22.76 per month on yearly engagements, without board, against $20.31 in 1879, which was the year of the greatest depression in value of agricultural labor, being an increase in two years of 10 per cent. But the cost of subsistence this year is $9 per month against $8.02 then, an increase of 12 per cent. This indication is rather unfavorable to the laborer in that section, as the cost of living has increased in a greater ratio than the value of labor. In the Middle States the wages of labor per month is this year $22.30 against $19.69 in the same year of depression as quoted above, while the cost of subsistence has only increased from $8.27 then to $8.83 this year. In the South Atlantic States, from Maryland to Florida, the rate of wages, without board, is not so valuable or reliable a datum as in the other sections of the country, from the fact that the custom is almost universal to hire labor, with board, or ration given weekly; the average price, however, as returned to this department for labor by the month, without board or ration, is $13.37; with board or ration, $8.83. To the same inquiry, two years since, the price returned was $11.19 without, and $7.67 with, ration and board. From all sections of these States there is reported a demand for labor and an increase in value, particularly for the skilled laborer.

The Gulf States, owing to the demand for railway laborers, added to the increase in production of Texas and Louisiana, report a great increase since the same time. The average wages of this section is $16.23, without board, and $11.29 with, against $14.80 and $9.80. The five States north of the Ohio River pay an average of $23.06 against $20.90 in 1879, and the cost of subsistence remains nearly the same as then, viz, $7.50 against $7.58, which indicates a gain very much in favor of labor. In all this section the demand for labor is reported as good, and the supply not equal to the needs of the farmer.

The six States west of the Mississippi pay an average of $25.84 per month. This average includes the wages paid in Colorado; leaving out the sum paid in that State, as not being wages of agricultural labor so much as labor in the mining districts, and there is reported for the five States of the West and Northwest an average of $23.41 without board, and $14.95 with board, making the cost of subsistence $8.46 per month. The two Pacific States report an average wage of $35.75 without board, and $23.63 with, being a decline since 1879, when the same values were returned as $38.22 and $25.10.

OUR AGRICULTURAL EXPORTS.

Statement of the exports of agricultural products of the United States, with their immediate manufactures, for the two fiscal years ending June 30, 1880, compiled from the Treasury report of commerce and navigation.

Products.	1879.		1880.	
	Quantity.	Value.	Quantity.	Value.
Animals, living:				
Hogs .... number..	75, 129	$700, 262	83, 434	$421, 089
Horned cattle .... do....	136, 720	8, 379, 200	182, 756	13, 344, 195
Horses .... do....	3, 915	770, 742	3, 060	675, 139
Mules .... do....	4, 153	530, 989	5, 198	532, 362
Sheep .... do....	215, 680	1, 082, 938	209, 137	892, 647
All other, and fowls	....	23, 623	....	16, 688
Animal matter:				
Bone-black, ivory-black, &c .... pounds..	1, 026, 127	48, 347	1, 249, 958	66, 069
Bones and bone-dust .... cwt..	42, 393	70, 800	32, 680	46, 431
Candles .... pounds..	1, 815, 699	225, 104	1, 954, 725	237, 627
Furs and fur-skins	....	4, 828, 158	....	5, 404, 418
Glue .... pounds..	394, 097	43, 779	150, 718	22, 650
Hair:				
Unmanufactured	....	279, 170	....	232, 726
Manufactures of	....	18, 629	....	24, 552
Hides and skins, other than furs	....	1, 171, 523	....	649, 074
Leather:				
Sorts not specified .... pounds..	28, 719, 623	5, 846, 882	21, 834, 492	5, 086, 118
Morocco, and other fine	....	953, 188	....	658, 242
Boots and shoes .... pairs..	329, 355	402, 557	378, 274	441, 069
Saddlery and harness	....	132, 699	....	133, 705
Other manufactures	....	433, 743	....	441, 052
Oil:				
Lard .... gallons..	1, 963, 208	1, 037, 923	1, 507, 596	816, 447
Other animal .... do....	145, 641	131, 832	30, 383	23, 519
Provisions:				
Bacon and hams .... pounds..	732, 249, 576	51, 074, 433	759, 773, 109	50, 987, 623
Beef, fresh .... do....	54, 025, 832	4, 883, 080	84, 717, 194	7, 441, 918
Beef, salted .... do....	36, 950, 563	2, 336, 378	45, 237, 472	2, 881, 047
Butter .... do....	38, 248, 016	5, 421, 205	39, 236, 658	6, 690, 687
Cheese .... do....	141, 654, 474	12, 579, 968	127, 553, 907	12, 171, 720
Condensed milk	....	119, 883	....	121, 013
Eggs .... dozen..	91, 740	14, 258	85 885	14, 148
Lard .... pounds..	326, 658, 686	22, 856, 673	374, 979, 286	27, 920, 367
Mutton, fresh .... do....	1, 440, 197	123, 013	2, 335, 858	176, 218
Pork .... do....	84, 401, 676	4, 807, 568	95, 949, 780	5, 930, 252
Preserved meats	....	7, 311, 408	....	7, 877, 200
Soap:				
Perfumed and toilet	....	30, 827	....	38, 567
All other .... pounds..	12, 297, 689	621, 311	14, 566, 891	690, 122
Tallow .... do....	99, 963, 752	6, 934, 940	110, 767, 627	7, 689, 232
Wax .... do....	168, 745	45, 823	193, 217	48, 880
Wool:				
Raw and fleece .... pounds..	60, 784	17, 044	191, 551	71, 987
Carpets .... yards..	8, 133	8, 118	8, 541	8, 530
Other manufactures	....	338, 615	....	208, 046
Total value of animals and animal matter..	....	146, 640, 233	....	161, 133, 376
Breadstuffs and other preparations:				
Barley .... bushels..	715, 536	401, 180	1, 128, 923	784, 819
Bread and biscuits .... pounds..	15, 565, 190	682, 471	14, 759, 755	686, 158
Corn .... bushels..	86, 296, 252	40, 655, 120	98, 169, 877	53, 298, 247
Corn meal .... barrels..	397, 160	1, 052, 231	350, 613	981, 361
Oats .... bushels..	5, 452, 136	1, 618, 644	766, 366	308, 129
Rye .... do....	4, 851, 715	3, 103, 970	2, 912, 754	2, 362, 765
Rye flour .... barrels..	4, 351	15, 113	5, 190	24, 728
Wheat .... bushels..	122, 353, 936	130, 701, 079	153, 252, 795	190, 546, 305
Wheat flour .... barrels..	5, 629, 714	29, 567, 713	6, 011, 419	35, 333, 197
Other small grain and pulse	....	817, 536	....	1, 272, 028
Other preparations of grain	....	1, 740, 471	....	2, 439, 098
Rice .... pounds..	740, 136	35, 538	183, 534	13, 366
Total value of breadstuffs, &c	....	210, 391, 066	....	288, 050, 201
Cotton and its manufactures:				
Sea Island .... pounds..	4, 030, 228	1, 108, 072	5, 061, 634	1, 683, 900
Other manufactures .... do....	1, 624, 342, 605	161, 196, 178	1, 816, 999, 480	209, 852, 005
Colored goods .... yards..	45, 116, 058	3, 209, 285	37, 758, 166	2, 956, 760
Uncolored .... do....	84, 081, 319	6, 288, 131	68, 821, 557	5, 834, 541
All other manufactures	....	1, 356, 534	....	1, 190, 117
Total value of cotton, &c	....	173, 158, 200	....	221, 517, 323

Statement of the exports of agricultural products, &c.—Continued.

Products.	1879.		1880.	
	Quantity.	Value.	Quantity.	Value.
Wood and its products:				
Boards, planks, joists, &c ....M feet..	275, 102	$3, 972, 608	285, 194	$4, 223, 259
Laths, palings, pickets, &c..............M..	4, 476	13, 002	4, 039	11, 936
Shingles ....do..	55, 858	176, 514	54, 311	165, 893
Box-shooks		103, 788		136, 082
Other shooks, staves, and headings		3, 666, 652		3, 510, 976
Hogsheads and barrels, empty......number..	148, 604	248, 085	149, 230	262, 029
All other lumber		680, 068		765, 550
Fire-wood ....cords..	3, 444	11, 096	3, 876	11, 552
Hop, hoop, telegraph, and other poles		466, 209		427, 187
Logs, masts, spars, and other whole timber		613, 706		691, 194
Timber, sawed and hewed ....cubic feet..	13, 255, 241	1, 748, 525	16, 365, 646	2, 210, 320
All other timber		164, 192		98, 733
Household furniture		1, 804, 296		1, 653, 878
Wooden ware		255, 770		331, 137
All other manufactures		1, 699, 992		1, 728, 650
Ashes, pot and pearl...............pounds..	1, 060, 691	61, 266	1, 231, 528	110, 578
Bark, for tanning		130, 939		210, 126
Resin and turpentine ....barrels..	1, 112, 816	2, 159, 141	1, 040, 345	2, 368, 180
Spirits of turpentine...............gallons..	7, 575, 556	2, 045, 673	7, 091, 200	2, 132, 154
Tar and pitch.......................barrels..	52, 350	101, 445	41, 221	84, 728
Total value of wood, &c		20, 122, 967		21, 143, 142
Miscellaneous:				
Brooms, brushes, &c		138, 184		110, 410
Cordage, ropes, and twine of all kinds.pounds.	3, 960, 351	391, 504	3, 229, 875	356, 808
Fruits:				
Apples, dried.....................pounds..	7, 379, 836	296, 794	3, 158, 367	192, 069
green or ripe ....bushels..	1, 388, 800	980, 455	1, 121, 754	1, 190, 560
Other green, ripe, or dried		252, 415		272, 715
Preserved in cans or otherwise		386, 718		435, 290
Ginseng ....pounds..	391, 264	465, 611	391, 083	533, 042
Hay ....tons..	8, 127	122, 122	13, 739	206, 819
Hemp:				
Unmanufactured.....................cwt..	1, 281	8, 155	1, 591	8, 796
Cable and cordage...................do..	16, 182	170, 179	16, 490	179, 979
All other manufactures		1, 153, 471		1, 083, 676
Hops ....pounds..	5, 458, 159	701, 095	9, 739, 566	2, 573, 293
Liquors, alcoholic, cider and beer:				
Ale and porter:				
In bottles ....dozens..	125, 873	204, 282	146, 739	262, 450
In casks.....................gallons..	93, 014	34, 987	111, 308	36, 368
Spirits distilled from—				
Grain.......................gallons..	7, 052, 366	2, 262, 150	10, 112, 598	2, 586, 685
Molasses.......................do....	1, 239, 082	398, 136	1, 285, 268	397, 247
Other materials................do....	20, 309	12, 955	20, 640	43, 613
Wine...........................do....	46, 224	49, 775	154, 887	123, 317
Oil-cake ....pounds..	340, 995, 395	4, 394, 010	453, 023, 225	6, 259, 827
Oil:				
Cotton-seed ....gallons..	5, 352, 793	2, 233, 068	6, 997, 796	3, 225, 414
Linseed ....do....	30, 416	22, 297	38, 431	31, 214
Essential or volatile		242, 329		219, 612
Seeds:				
Cotton.........................pounds..	16, 397, 398	141, 188	12, 142, 137	134, 116
Clover............................do..			26, 526, 295	2, 401, 351
Flax or lint......................do....	49	107		
All other		2, 141, 533		241, 356
Starch ....pounds..	14, 298, 654	601, 797	10, 311, 736	447, 842
Sugar:				
Brown.........................pounds..	43, 955	3, 202	16, 858	1, 064
Refined...........................do..	73, 309, 009	6, 164, 024	30, 125, 146	2, 717, 563
Molasses.......................gallons..	4, 727, 367	919, 173	3, 596, 010	539, 603
Candy and confectionery		32, 274		81, 757
Tobacco:				
Leaf...........................pounds..	322, 279, 540	25, 157, 364	215, 910, 187	16, 379, 107
Cigars ....M..	2, 299	53, 397	2, 583	67, 821
Snuff ....pounds..	13, 522	5, 846	15, 883	6, 074
Other manufactures		2, 998, 633		1, 989, 271
Vegetables, &c.:				
Onions ....bushels..	64, 695	60, 022	55, 152	50, 074
Pickles and sauces		12, 908		17, 158
Potatoes ....bushels..	625, 342	545, 109	696, 080	522, 039
All other		79, 530		89, 053
Vinegar ....gallons..	22, 873	6, 227	16, 534	4, 123
Total value of miscellaneous products		53, 843, 026		46, 018, 575

Statement of the exports of agricultural products, &c.—Continued.

RECAPITULATION.

Products.	1871.	1872.	1873.	1874.	1875.
Animals and animal matter....	$47,010,312	$77,060,849	$99,806,599	$99,697,669	$104,314,988
Breadstuffs, &c................	79,519,387	85,155,523	98,762,891	161,225,939	111,478,096
Cotton, &c	221,885,245	182,988,925	230,190,597	214,319,420	194,710,507
Wood, &c	15,820,029	21,425,068	25,854,120	27,675,300	22,875,814
Miscellaneous	33,060,081	40,139,206	37,901,458	45,486,626	45,294,411
Total agricultural exports.	397,205,054	406,769,661	492,515,665	548,314,954	478,673,816
Total exports	562,518,651	549,219,718	649,132,563	693,039,066	643,694,767
Per cent. of agricultural matter.	70	74	76	79	74

Products.	1876.	1877.	1878.	1879.	1880.
Animals and animal matter....	113,941,509	140,564,066	145,587,515	146,640,233	161,133,376
Breadstuffs, &c................	131,212,471	118,126,940	181,811,794	210,391,066	288,050,201
Cotton, &c	200,382,240	183,253,248	191,470,144	173,158,200	221,517,323
Wood, &c	21,620,486	23,422,966	21,747,107	20,122,967	21,143,142
Miscellaneous	46,079,567	58,652,719	52,245,306	53,843,026	46,018,575
Total agricultural exports.	513,236,273	524,019,939	592,861,876	604,155,492	737,862,617
Total exports..............	644,956,406	689,167,390	722,811,815	717,093,777	823,946,353
Per cent. of agricultural matter.	79	76	82	84	89.5 +

The exportation of butter and cheese during the year ending June 30, 1880, shows a slight decrease in the export of cheese, but the enhanced value per pound makes the value but little less. The export of butter was nearly identical in number of pounds, but largely in excess in value. The following table gives the total export and value since ten years, and will show the enormous increase since then. Fully three-fourths of the export is to Great Britain, the balance almost entirely to British America and the West Indies:

Exports of dairy products.

Year ending June 30—	Butter.	Value.	Cheese.	Value.
	Pounds.		*Pounds.*	
1871..............................	3,965,043	$853,096	63,698,867	$8,752,990
1872..............................	7,746,261	1,148,812	66,204,025	7,752,918
1873..............................	4,518,844	952,919	80,366,540	10,498,010
1874..............................	4,367,983	1,092,381	90,611,077	11,898,995
1875..............................	6,360,827	1,506,996	101,010,853	13,659,603
1876..............................	4,644,894	1,109,496	97,676,264	12,270,083
1877..............................	21,527,242	4,424,616	107,364,666	12,700,627
1878..............................	21,837,117	3,931,822	123,783,736	14,103,520
1879..............................	38,248,016	6,421,205	141,654,474	12,579,968
1880..............................	39,236,658	6,690,687	127,553,907	12,171,720

DISTRIBUTION OF OUR AGRICULTURAL EXPORTS.

ANIMALS AND ANIMAL MATTER.—A comparison of the values of live animals exported in 1880 with those of 1879 shows an increase of 38 per cent. in the aggregate of the five classes of animals, the gain being, however, almost entirely in cattle. The value of mules exported amounted to $532,362, against $530,989 in 1879; but with these two exceptions there was a decline, which was especially marked in hogs, the drop being from $700,262 in 1879 to $421,089 in 1880. This decrease was caused by a great fall in price, the average for each animal in 1879 being $9.32, against $5.05 in 1880, while the number exported increased from 75,129 to 83,434. The only other noticeable decline was in sheep,

which fell in numbers from 215,680 to 209,137, and in price from $5.02 to $4.27, thus reducing the aggregate value from $1,082,938 to $892,647. The number of horses shipped declined from 3,915 to 3,060, a reduction of 22 per cent., but the average price rose from $196.87 to $220.63, making the decrease in aggregate value only 12 per cent. The most noticeable feature of the distribution of this export is the great falling off in the value of animals sent to British North America, *i. e.*, from $1,053,592 to $469,136, a decline of 56 per cent. The greatest decrease was in cattle, which fell from $518,135 to $92,943. Not only was their number reduced from 8,555 to 4,908, but the price also fell from $60.56 to $32.73.

An examination of the subjoined table will show the movement in detail, and enable those interested to make further comparisons and deductions:

Animals.	United Kingdom.	Continental Europe.	British North America.	Mexico.
Cattle:				
Number	125,742	4,908	2,340	992
Aggregate value	$11,847,642	$513,300	$92,943	$10,633
Average value	$94 22	$104 58	$32 73	$10 72
Hogs:				
Number	10,399	973	70,864	544
Aggregate value	$95,151	$17,510	$299,265	$1,689
Average value	$9 15	$17 99	$4 22	$3 10
Horses:				
Number	788	467	411	673
Aggregate value	$340,732	$148,300	$59,687	$11,374
Average value	$432 27	$317 63	$145 22	$16 90
Mules:				
Number	359	....	50	92
Aggregate value	$27,400	....	$2,500	$1,538
Average value	$76 32	....	$50 00	$16 71
Sheep:				
Number	80,776	1,731	6,910	115,265
Aggregate value	$704,979	$15,310	$14,129	$120,817
Average value	$8 73	$8 84	$2 04	$1 05
Other, aggregate value	$810	$100	$612	$5,861
Total value to each country:				
1880	$13,016,714	$694,520	$469,136	$151,912
1879	8,167,796	499,100	1,053,592	149,827

Animals.	Central and South America.	West Indies.	Japan.	Other countries.	Total exports.
Cattle:					
Number	56	47,931	87	200	182,756
Aggregate value	$4,220	$856,808	$4,995	$13,654	$13,344,195
Average value	$75 36	$17 87	$57 41	$68 27	$73 02
Hogs:					
Number	22	162	....	470	83,434
Aggregate value	$573	$1,293	....	$5,608	$421,089
Average value	$26 04	$7 99	....	$11 93	$5 05
Horses:					
Number	113	501	5	102	3,060
Aggregate value	$24,310	$71,340	$2,150	$17,246	$675,139
Average value	$215 13	$142 39	$430	$169 27	$220 63
Mules:					
Number	376	3,823	....	498	5,198
Aggregate value	$45,805	$404,130	....	$50,989	$532,362
Average value	$148 42	$105 71	....	$102 49	$102 42
Sheep:					
Number	2,008	1,611	720	116	209,137
Aggregate value	$13,445	$12,992	$8,200	$2,775	$892,647
Average value	$6 69	$8 00	$11 03	$23 06	$4 27
Other, aggregate value	$236	$6,249	$345	$2,475	$16,688
Total value to each country:					
1880	$88,589	$1,352,812	$15,600	$92,747	$15,882,120
1879	61,810	1,380,963	14,500	160,167	11,487,754

PORK AND ITS PRODUCTS.—The total value of this class of exports in 1880 was 7 per cent. greater than that of 1879, reaching an aggregate of $85,654,689 as against $79,776,597. An increased demand for lard in nearly every country offering a market for it, even at an enhanced price, accounts in a great degree for the advance in the aggregate value of this division of dead animal matter, though pork also went abroad in larger quantities and at higher prices. The value of lard exported was $27,920,367, against $22,856,673 in 1879, while pork advanced from $4,807,568 to $5,930,252. The only very marked changes in the proportions of this class taken by the different countries are a considerable reduction in the purchase of bacon and hams by Germany, Belgium, and Netherlands, and a very decided increase in that of lard by British North America. The percentage of the total export taken by our northern neighbors on this side of the Atlantic is, however, so small that the increase did not greatly disturb the relations of the movement as to quantities or prices.

The following table gives the figures in detail:

Articles.	United Kingdom.	France.	Germany.	Belgium and Netherlands.	British North America.
Bacon and hams:					
Pounds	555, 013, 833	66, 357, 041	26, 843, 862	76, 687, 985	5, 822, 450
Value	$37, 737, 609	$3, 848, 930	$1, 786, 494	$4, 951, 967	$476, 981
Average per pound	$0 06. 8	$0 05. 8	$0 06. 7	$0 06. 5	$0 08. 2
Lard:					
Pounds	112, 834, 201	55, 462, 701	85, 509, 388	44, 316, 840	9, 378, 935
Value	$8, 355, 000	$3, 941, 971	$6, 379, 894	$3, 295, 581	$631, 787
Average per pound	$0 07. 4	$0 07. 1	$0 07. 4	$0 07. 4	$0 06. 7
Pork:					
Pounds	36, 997, 976	1, 608, 545	1, 259, 417	396, 740	20, 987, 080
Value	$2, 543, 410	$104, 329	$79, 364	$23, 128	$1, 185, 935
Average per pound	$0 06. 9	$0 06. 5	$0 06. 3	$0 05. 7	$0 05. 6
Lard oil:					
Gallons	912, 115	341, 728	24, 149	28, 512	11, 451
Value	$487, 250	$177, 472	$14, 516	$15, 203	$6, 640
Average per gallon	$0 53. 4	$0 51. 9	$0 60. 1	$0 53. 3	$0 58. 1
Total value to each country:					
1880	$49, 123, 260	$8, 072, 702	$8, 260, 268	$8, 285, 879	$2, 301, 344
1879	47, 480, 072	6, 444, 773	8, 275, 875	7, 793, 550	1, 316, 256

Articles.	West Indies.	Mexico, Central and South America.	Other countries in Europe.	All other countries.	Totals.
Bacon and hams:					
Pounds	11, 242, 554	1, 407, 798	15, 886, 754	509, 832	759, 772, 109
Value	$958, 202	$137, 502	$1, 032, 150	$57, 788	$50, 987, 623
Average per pound	$0 08. 5	$0 09. 7	$0 06. 5	$0 11. 3	$0 06. 7
Lard:					
Pounds	29, 741, 290	20, 712, 610	16, 120, 392	902, 929	374, 979, 286
Value	$2, 275, 850	$1, 750, 920	$1, 213, 274	$76, 090	$27, 920, 367
Average per pound	$0 07. 6	$0 08. 4	$0 07. 5	$0 08. 4	$0 07. 4
Pork:					
Pounds	27, 771, 939	5, 638, 791	108, 087	1, 181, 205	95, 949, 780
Value	$1, 576, 887	$340, 856	$7, 150	$69, 193	$5, 930, 252
Average per pound	$0 05. 6	$0 06. 0	$0 06. 6	$0 05. 8	$0 06. 2
Lard oil:					
Gallons	12, 413	124, 055	1, 430	51, 743	1, 507, 596
Value	$7, 402	$73, 404	$716	$33, 843	$816, 447
Average per gallon	$0 59. 1	$0 59. 2	$0 50. 1	$0 65. 8	$0 54. 1
Total value to each country:					
1880	$4, 818, 341	$2, 302, 682	$2, 253, 290	$236, 914	$85, 654, 689
1879	4, 614, 893	2, 165, 195	1, 418, 701	267, 282	79, 776, 597

BEEF AND ITS PRODUCTS.—The aggregate value of these exports for the past year is $44,688,673, against $41,609,761 in 1879, showing an

increase of $3,078,912, or over 7 per cent. The United Kingdom is our great customer for this class of productions, taking 78 per cent. of the whole amount exported, and it is to the increased demand in this quarter that we owe the aggregate gain above quoted, as there was a considerable falling off in the export values of all the other countries except the West Indies, Mexico, and Central and South America, which slightly increased their demand. Germany showed the greatest decline, her consumption falling from $3,939,733 to $2,720,763, equal to nearly 30 per cent.

The value of cheese is nearly double that of any other product in the schedule, and the United Kingdom takes 96 per cent. of all exported. The aggregate for 1880 was $12,171,720, a slight decline from that of 1879. The export values of tallow and fresh beef are nearly equal, somewhat over half of the former and nearly all of the latter finding their way to the United Kingdom. Of tallow the value for 1880 was $7,689,232, against $6,934,940 in 1879, while fresh beef increased from $4,883,080 to $7,441,918. The average prices of the articles embraced in this class have not varied materially, the increase in butter from 14.2 cents to 17.1 cents being the most important. There are minor changes, however, in distribution, values, &c., which will appear upon examination of the following table:

Articles.	United Kingdom.	France.	Germany.	Belgium and Netherlands.	British North America.
Fresh beef:					
Pounds	84, 454, 881	....	....	....	191, 422
Value	$7, 425, 255	....	....	....	$10, 285
Average per pound	$0 08. 8	....	....	....	$0 05. 4
Salted beef:					
Pounds	29, 592, 601	1, 011, 175	2, 516, 769	1, 339, 810	1, 956, 657
Value	$1, 893, 103	$59, 946	$178, 182	$84, 667	$106, 125
Average per pound	$0 06. 4	$0 05. 9	$0 07. 1	$0 06. 3	$0 05. 4
Butter:					
Pounds	27, 887, 893	446, 693	5, 349, 549	50, 492	983, 701
Value	$4, 903, 848	$65, 611	$663, 720	$6, 656	$157, 647
Average per pound	$0 17. 6	$0 14. 7	$0 10. 8	$0 13. 2	$0 16. 0
Cheese:					
Pounds	122, 165, 332	42, 427	550, 281	35, 610	2, 962, 569
Value	$11, 691, 477	$3, 887	$45, 123	$4, 968	$204, 953
Average per pound	$0 09. 5	$0 09. 2	$0 08. 2	$0 13. 9	$0 06. 9
Condensed milk, value	$38, 633	....	$191	$495	$2, 550
Tallow:					
Pounds	61, 982, 939	10, 776, 901	11, 688, 328	9, 441, 278	3, 281, 454
Value	$4, 515, 589	$701, 920	$749, 253	$646, 565	$183, 216
Average per pound	$0 07. 2	$0 06. 5	$0 06. 4	$0 06. 8	$0 05. 6
Glue:					
Pounds	43, 736	150	6, 595	12, 736	61, 299
Value	$5, 013	$18	$989	$1, 548	$11, 191
Average per pound	$0 11. 5	$0 12. 0	$0 15. 0	$0 12. 1	$0 18. 2
Hides, value	$158, 193	$86, 187	$51, 223	$3, 236	$344, 106
Neatsfoot oil:					
Gallons	24, 406	1, 500	600	2, 118	298
Value	$18, 478	$1, 100	$460	$2, 073	$204
Average per gallon	$0 75. 7	$0 73. 3	$0 76. 7	$0 97. 8	$0 68. 4
Candles:					
Pounds	13, 483	41, 815	738	....	75, 964
Value	$1, 812	$7, 835	$177	....	$8, 721
Average per pound	$0 13. 4	$0 18. 7	$0 24. 0	....	$0 11. 5
Leather:					
Pounds	16, 667, 052	5, 131	3, 970, 742	451, 294	334, 467
Value	$3, 877, 510	$800	$914, 791	$108, 748	$85, 666
Average per pound	$0 23. 3	$0 15. 6	$0 23. 0	$0 24. 1	$0 25. 6
Morocco, value	$440, 399	$300	$15, 572	$71, 328	$6, 603
Manufactures of leather, value	$96, 053	$2, 762	$101, 082	$31, 402	$113, 933
Total to each country:					
1880	$35, 065, 363	$930, 366	$2, 720, 763	$961, 686	$1, 235, 200
1879	29, 944, 469	1, 684, 541	3, 939, 733	1, 240, 485	1, 325, 618

Articles.	West Indies.	Mexico, Central and South America.	Other countries in Europe.	All others.	Totals.
Fresh beef:					
Pounds	49, 441	4, 650	....	16, 800	84, 717, 194
Value	$4, 421	$264	....	$1, 693	$7, 441, 918
Average per pound	$0 08. 9	$0 05. 7	....	$0 10. 8	$0 08. 8
Salted beef:					
Pounds	5, 028, 248	2, 165, 228	487, 898	1, 139, 086	45, 237, 472
Value	$331, 324	$139, 665	$31, 489	$56, 546	$2, 881, 047
Average per pound	$0 06. 6	$0 06. 3	$0 06. 4	$0 04. 9	$0 06. 4
Butter:					
Pounds	2, 584, 759	1, 443, 514	20, 841	469, 216	39, 236, 658
Value	$469, 815	$319, 472	$2, 833	$101, 085	$6, 690, 687
Average per pound	$0 18. 2	$0 22. 1	$0 13. 6	$0 21. 5	$0 17. 1
Cheese:					
Pounds	1, 287, 207	397, 043	3, 694	109, 744	127, 553, 907
Value	$160, 066	$45, 285	$308	$15, 653	$12, 171, 720
Average per pound	$0 12. 4	$0 11. 4	$0 08. 3	$0 14. 2	$0 09. 5
Condensed milk, value	$24, 154	$23, 257	$35	$31, 698	$121, 013
Tallow:					
Pounds	904, 136	3, 009, 189	9, 547, 698	135, 704	110, 767, 627
Value	$63, 597	$215, 275	$604, 837	$8, 980	$7, 689, 232
Average per pound	$0 07. 0	$0 07. 1	$0 06. 3	$0 06. 6	$0 06. 9
Glue:					
Pounds	15, 977	4, 515	514	5, 196	150, 718
Value	$2, 565	$661	$521	$144	$22, 650
Average per pound	$0 16. 1	$0 14. 6	....	$0 10. 7	$0 15. 0
Hides, value	$1, 245	1, 936	$760	$2, 188	$649, 074
Neatsfoot oil:					
Gallons	68	63	....	1, 330	30, 383
Value	$61	$55	....	$1, 088	$23, 519
Average per gallon	$0 89. 4	$0 87. 3	....	$0 81. 8	$0 77. 4
Candles:					
Pounds	884, 578	893, 132	1, 253	43, 762	1, 954, 725
Value	$102, 911	$111, 011	$165	$4, 995	$237, 627
Average per pound	$0 11. 6	$0 12. 4	$0 13. 2	$0 11. 4	$0 12. 2
Leather:					
Pounds	41, 234	24, 550	88, 416	251, 606	21, 834, 492
Value	$8, 955	$6, 073	$20, 230	$63, 345	$5, 086, 118
Average per pound	$0 21. 7	$0 24. 7	$0 22. 9	$0 25. 1	$0 23. 3
Morocco, value	$23, 073	$36, 860	$389	$63, 718	$658, 242
Manufactures of leather, value	$185, 219	$272, 498	$66, 193	$146, 684	$1, 015, 826
Total to each country:					
1880	$1, 377, 406	$1, 172, 312	$727, 760	$497, 817	$44, 688, 673
1879	1, 166, 315	910, 497	791, 299	606, 804	41, 609, 761

BREADSTUFFS.—An increase of $77,579,135 in the value of breadstuffs exported in 1880—equivalent to nearly 27 per cent.—is shown by a comparison with 1879. Of the aggregate of $287,970,201 received for grains and their preparations, about $260,000,000, or 90 per cent., came from across the ocean, the United Kingdom and France being the principal purchasers, the former to the amount of $154,537,944, and the latter $60,509,589, an increase of about 44 and 25 per cent. respectively over their imports for 1879. The value of the total exports of wheat and wheat flour foots up $225,799,502, and of corn and meal $54,279,608, leaving but $7,891,091 as representing all other grains and preparations. The great rise in the export value of wheat and corn, both ground and unground, resulted from increase in quantity as well as a very decided rise in prices, as shown by the tables. Wheat increased from 122,353,936 bushels at $1.06 per bushel in 1879, to 153,252,795 bushels, at $1.24.3 in 1880, and flour from 5,629,714 barrels at $5.25, to 6,011,419 barrels at $5.87.8. The percentage of increase in corn exports was not so great, but still marked. In 1879 we sent abroad 86,296,252 bushels of corn at an average price of 47.1 cents, producing a value of $40,655,120, and of meal 397,160 barrels at $2.65, giving $1,052,231, thus making a total valuation of $41,707,351, while our exports in 1880 were, of corn 98,169,877 bushels at $54.3 cents, giving $53,298,247, and of meal 350,613 barrels at $2.80, producing $981,361, the aggregate value being $54,279,608, as against $41,707,351 as above quoted.

The usual table by countries and articles is presented:

Articles.	United Kingdom.	France.	Germany.	Belgium and Netherlands.	Other countries in Europe.
Barley:					
Bushels	797, 583	....	460	....	1, 500
Value	$628, 440	....	$368	....	$1, 260
Average per bushel	$0 78. 8	....	$0 80. 0	....	$0 84. 0
Bread:					
Pounds	3, 865	....	7, 000	6, 050	6, 845
Value	$246	....	$490	$183	$346
Average per pound	$0 06. 4	....	$0 07. 0	$0 03. 0	$0 05. 0
Indian corn:					
Bushels	55, 635, 347	8, 573, 845	7, 589, 858	3, 650, 516	13, 751, 378
Value	$30, 744, 718	$4, 748, 293	$4, 082, 354	$1, 956, 672	$7, 650, 651
Average per bushel	$0 55. 3	$0 55. 4	$0 53. 8	$0 53. 6	$0 55. 6
Indian corn meal:					
Barrels	17, 434	....	....	183	659
Value	$58, 431	....	....	$431	$2, 031
Average per barrel	$3 35. 0	....	....	$2 35. 0	$3 08. 0
Oats:					
Bushels	46, 082	228, 983	....	191	25
Value	$17, 378	$87, 646	....	$135	$14
Average per bushel	$0 37. 7	$0 38. 3	....	$0 70. 7	$0 56. 0
Rye:					
Bushels	297, 769	348, 438	345, 753	1, 774, 983	126, 693
Value	$229, 801	$317, 855	$266, 990	$1, 433, 570	$102, 066
Average per bushel	$0 77. 2	$0 91. 2	$0 77. 2	$0 80. 8	$0 80. 5
Rye flour:					
Barrels	....	....	10	100	....
Value	....	....	$30	$600	....
Average per barrel	....	....	$3 00. 0	$6 00. 0	....
Wheat:					
Bushels	79, 068, 075	43, 601, 291	1, 223, 279	16, 763, 889	4, 168, 304
Value	$99, 313, 477	$55, 268, 075	$1, 386, 625	$20, 509, 855	$5, 212, 029
Average per bushel	$1 25. 6	$1 26. 7	$1 13. 4	$1 22. 3	$1 25. 1
Wheat flour:					
Barrels	3, 645, 952	9, 933	11, 911	79, 190	23, 444
Value	$21, 045, 460	$64, 009	$67, 787	$435, 030	$139, 660
Average per barrel	$5 77. 2	$6 44. 4	$5 69. 1	$5 49. 3	$5 95. 7
Other small grain, and pulse, value	$398, 769	$15, 512	$3, 218	$13, 740	$114, 387
Other preparations of grain, value	$2, 100, 736	$4, 243	$20, 719	$13, 780	$2, 594
Rice:					
Pounds	6, 268	52, 049	2, 443	616	900
Value	$488	$3, 956	$243	$50	$60
Average, per pound	$0 07. 8	$0 07. 6	$0 09. 9	$0 08. 1	$0 06. 7
Total value to each country:					
1880	$154, 537, 944	$60, 509, 589	$5, 828, 824	$24, 364, 046	$13, 225, 098
1879	107, 092, 081	48, 701, 907	2, 845, 123	15, 692, 750	8, 596, 700

Articles.	British North America.	Mexico, Central, and South America.	West Indies.	All others.	Totals.
Barley:					
Bushels	21, 857	104, 375	....	203, 152	1, 128, 923
Value	$11, 888	$46, 311	....	$96, 552	$784, 819
Average per bushel	$0 54. 4	$0 44. 4	....	$0 47. 5	$0 69. 5
Bread:					
Pounds	147, 318	4, 390, 681	8, 470, 964	1, 727, 032	14, 759, 755
Value	$8, 375	$244, 786	$344, 030	$87, 702	$686, 158
Average per pound	$0 05. 7	$0 05. 6	$0 04. 1	$0 05. 1	$0 04. 6
Indian corn:					
Bushels	7, 187, 203	421, 438	956, 368	403, 924	98, 169, 877
Value	$3, 005, 691	$291, 803	$557, 254	$260, 811	$53, 298, 247
Average per bushel	$0 41. 8	$0 69. 2	$0 58. 3	$0 64. 5	$0 54. 3
Indian corn meal:					
Barrels	169, 131	14, 437	147, 285	1, 478	350, 613
Value	$407, 831	$43, 998	$464, 087	$4, 552	$981, 361
Average per barrel	$2 41. 0	$3 05. 0	$3 15. 0	$3 08. 0	$2 80. 0

Articles.	British North America.	Mexico, Central, and South America.	West Indies.	All others.	Totals.
Oats:					
Bushels	193, 913	22, 032	237, 101	38, 039	766, 366
Value	\$58, 356	\$10, 567	\$116, 654	\$17, 379	\$308, 129
Average per bushel	\$0 30. 1	\$0 48. 0	\$0 49. 2	\$0 45. 7	\$0 40. 2
Rye:					
Bushels	18. 584	....	34	500	2, 912, 754
Value	\$12, 057	....	\$37	\$380	\$2, 362, 765
Average per bushel	\$0 64. 9	....	\$1 09. 0	\$0 76. 0	\$0 81. 1
Rye flour:					
Barrels	82	306	4, 687	5	5, 190
Value	\$418	\$1, 756	\$21, 900	\$24	\$24, 728
Average per barrel	\$5 10. 0	\$5 74. 0	\$4 67. 0	\$4 80. 0	\$4 76. 0
Wheat:					
Bushels	7, 920, 248	398, 152	49, 420	60, 137	153, 252, 795
Value	\$8, 145, 567	\$480, 241	\$71, 926	\$78, 510	\$190, 466, 305
Average per bushel	\$1 02. 8	\$1 20. 6	\$1 45. 5	\$1 30. 5	\$1 24. 3
Wheat flour					
Barrels	277, 666	919, 977	757, 432	285, 914	6, 011, 419
Value	\$1, 384, 425	\$5, 998, 186	\$4, 672, 444	\$1, 526, 196	\$35, 333, 197
Average per barrel	\$4 98. 6	\$6 52. 0	\$6 16. 9	\$5 33. 8	\$5 87. 8
Other small grain, and pulse, value	\$104, 208	\$134, 851	\$440, 632	\$46, 801	\$1, 272, 028
Other preparations of grain, value	\$17, 857	\$80, 484	\$122, 713	\$75, 972	\$2, 439, 098
Rice:					
Pounds	20, 217	60, 056	38, 485	2, 500	183, 534
Value	\$1, 537	\$4, 633	\$2, 293	\$106	\$13, 366
Average per pound	\$0 07. 6	\$0 07. 7	\$0 06. 0	\$0 04. 2	\$0 07. 2
Total value to each country:					
1880	\$13, 158, 210	\$7, 337, 616	\$6, 813, 970	\$2, 194, 985	\$287, 970, 201
1879	11, 176, 492	7, 217, 984	6, 273, 253	2, 794, 776	210, 391, 066

COTTON AND COTTON MANUFACTURES.—The value of exports of this class for 1880 shows an increase of nearly 28 per cent. over 1879, the aggregate reaching \$221,517,323, against \$173,158,200. To this total the United Kingdom contributed \$144,636,841, or about 65 per cent. in 1880, while in 1879 we received from the same source \$101,418,146, less than 59 per cent. of that year's total export. These figures show an increased demand on her part of about 42 per cent. France and Germany are the next largest customers, contributing \$20,890,745, and \$17,887,683 respectively for their cotton supplies drawn from this country representing an increase of 9 per cent. for the former, and 34 per cent. for the latter over the values of 1879. Of the cotton exports, \$211,535,905 were for raw cotton, leaving only about \$10,000,000 for woven goods and all other manufactures, an amount slightly less than the receipts for manufactured goods in 1879. The exports of Sea Island cotton increased about 1,000,000 pounds, and the price advanced from 27.5 cents per pound to 33.3 cents, the total value for 1880 being \$1,683,900. About four-fifths of the total export was to the United Kingdom, France and Germany absorbing the remainder, Germany's proportion, however, being almost too insignificant for mention. The price of other raw cotton advanced from 9.9 cents to 11.5 cents, with an increase in the quantity exported of nearly 12 per cent.

There was a very slight falling off in the aggregate value derived from manufactures of cotton, notwithstanding the fact that the United Kingdom bought nearly 30 per cent. more in 1880 than in 1879. The changes in distribution are otherwise not very great. In her purchases of woven goods, the United Kingdom showed an increased preference for uncolored over colored fabrics. In 1879 41 per cent. of the value of her imports of such goods from the United States was paid for colored goods, while in 1880 the percentage was but 17.

The accompanying table presents a full exhibit of the movement:

Articles.	United Kingdom.	France.	Germany.	Belgium and Netherlands.	Other countries in Europe.
Sea Island cotton:					
Bales	11, 220	2, 776	98	....	....
Pounds	4, 014, 826	1, 014, 226	32, 582	....	....
Value	$1, 321, 693	$348, 814	$13, 393	....	....
Average per pound	$0 32. 9	$0 34. 4	$0 41. 1	....	....
Other raw cotton:					
Bales	2, 538, 598	374, 556	322, 386	80, 598	438, 297
Pounds	1,212,612,358	178, 832, 051	153, 989, 982	41, 610, 769	210, 147, 248
Value	$139, 793, 390	$20, 519, 874	$17, 708, 261	$4, 336, 392	$25, 148, 935
Average per pound	$0 11. 5	$0 11. 5	$0 11. 5	$0 10. 4	$0 12. 0
Colored goods:					
Yards	6, 091, 998	2, 500	175, 516	7, 395	2, 300
Value	$471, 914	$199	$16, 763	$759	$190
Average per yard	$0 07. 7	$0 07. 9	$0 09. 5	$0 10. 2	$0 08. 0
Uncolored goods:					
Yards	32, 896, 360	222, 023	1, 662, 625	124, 074	141, 515
Value	$2, 712, 646	$20, 087	$123, 141	$13, 054	$14, 762
Average per yard	$0 08. 2	$0 08. 5	$0 07. 5	$0 10. 5	$0 10. 4
All other manufactures, value	$337, 198	$1, 851	$26, 125	$2, 565	$2, 537
Total value to each country:					
1880	$144, 636, 841	$20, 890, 745	$17, 887, 683	$4, 352, 770	$25, 166, 424
1879	101, 418, 146	19, 076, 084	13, 301, 822	3, 508, 566	26, 187, 905

Articles.	British North America.	Mexico, Central and South America.	West Indies.	All others.	Totals.
Sea Island cotton:					
Bales	....	....	....	....	14, 094
Pounds	....	....	....	....	5, 061, 634
Value	....	....	....	....	$1, 683, 900
Average per pound	....	....	....	....	$0 33. 3
Other raw cotton:					
Bales	20, 335	21, 282	2	5	3, 796, 059
Pounds	9, 809, 633	9, 993, 854	1, 049	2, 536	1,816,999,480
Value	$1, 154, 978	$1, 189, 784	$109	$282	$209, 852, 005
Average per pound	$0 11. 8	$0 11. 9	$0 10. 4	$0 11. 1	$0 11. 5
Colored goods:					
Yards	393, 912	18, 187, 923	5, 338, 143	7, 558, 479	37, 758, 166
Value	$32, 563	$1, 428, 460	$451, 014	$541, 898	$2, 956, 760
Average per yard	$0 08. 3	$0 07. 8	$0 08. 5	$0 07. 2	$0 07. 8
Uncolored goods:					
Yards	2, 157, 255	12, 899, 366	3, 958, 993	14, 759, 346	68, 821, 557
Value	$252, 016	$1, 184, 826	$420, 407	$1, 093, 602	$5, 834, 541
Average per yard	$0 11. 6	$0 09. 2	$0 10. 6	$0 07. 4	$0 08. 5
All other manufactures, value	$336, 873	$230, 453	$72, 381	$180, 134	$1, 190, 117
Total value to each country:					
1880	$1, 778, 420	$4, 033, 523	$943, 911	$1, 815, 916	$221, 517, 323
1879	1, 781, 014	3, 923, 724	970, 453	2, 990, 486	173, 158, 200

MISCELLANEOUS.—There was a falling off in the value of this class of exports from $50,301,555 to $41,768,641, equal to 17 per cent., the proportional decrease being much greater in Germany and British North America than elsewhere. In 1879, the former expended $8,809,706 and the latter $3,069,722 for the various commodities under the above head,

aggregating 23 per cent. of the total receipt from all sources, while, in 1880, Germany fell to $4,667,801 and British North America $1,444,886, but about 15 per cent.

Quite marked changes are observable in the relative importance as well as the actual values of some of the leading articles, in comparing the figures for the two years. Tobacco and its manufactures produced in 1879 $28,215,240, or 56 per cent. of the total receipts, but in 1880 the value fell to $18,432,273 and the percentage to 44. Sugar and molasses ranked second in 1879, commanding $7,083,197, or 14 per cent. of the total of that year, while in 1880 the value was reduced to $3,257,166 and the percentage to less than 8. These reductions in value were due to a lessened demand, the prices being little changed. Most of the other miscellaneous articles were increasingly sought for, but the excess of receipts was not sufficiently great to overbalance the decline in tobacco and sugar.

Articles.	United Kingdom.	France.	Germany.	Belgium and Netherlands.	Other countries of Europe.
Fruits, value	$1,460,907	$18,665	$108,761	$34,472	$783
Hemp and products, value	$623,943	$123,555	$55,941	$125,227	$100,263
Hops:					
Pounds	9,433,239	48,188	7,469	50	....
Value	$2,504,156	$6,075	$2,350	$14	....
Average per pound	$0 26.5	$0 12.6	$0 31.3	$0 28.0	....
Spirits:					
Gallons	74,805	2,737,226	410,682	188,245	5,721,182
Value	$32,847	$707,439	$147,159	$36,167	$1,399,569
Average per gallon	$0 43.9	$0 25.8	$0 35.8	$0 19.2	$0 24.5
Oil-cake:					
Pounds	442,293,863	22,400	3,214,817	144,530	....
Value	$6,084,772	$260	$38,244	$2,250	....
Average per pound	$0 01.4	$0 01.2	$0 01.2	$0 01.6	....
Oil, cotton-seed:					
Gallons	264,083	1,430,231	48	60,393	5,237,724
Value	$109,084	$656,848	$22	$32,651	$2,424,068
Average per gallon	$0 41.3	$0 45.9	$0 45.8	$0 54.0	$0 46.3
Seed cotton:					
Pounds	12,056,254	49,125	....	....	....
Value	$131,091	$2,080	....	....	....
Average per pound	$0 01.1	$0 04.2	....	....	....
Starch:					
Pounds	1,995,676	2,125	2,668,649	2,629,084	215,506
Value	$97,925	$80	$118,650	$101,089	$7,873
Average per pound	$0 04.9	$0 03.6	$0 04.4	$0 03.8	$0 03.6
Sugar, refined:					
Pounds	17,851,278	....	145,209	....	39,464
Value	$1,614,579	....	$11,006	....	$3,694
Average per pound	$0 09.0	....	$0 07.6	....	$0 09.4
Molasses:					
Gallons	3,224,168	73,065	156,937	1,010	53,499
Value	$338,408	$8,020	$40,742	$300	$18,006
Average per gallon	$0 10.5	$0 11.0	$0 25.9	$0 29.7	$0 33.7
Tobacco, leaf:					
Pounds	33,996,486	26,921,601	59,495,964	36,178,463	38,830,765
Value	$3,693,709	$1,646,021	$4,065,898	$2,386,359	$2,380,853
Average per pound	$0 10.9	$0 06.1	$0 06.8	$0 06.6	$0 06.1
Tobacco, manufactures, value	$720,554	$6,129	$81,028	$110,387	$31,775
Potatoes:					
Bushels	63,366	467	....	82	450
Value	$49,672	$460	....	$88	$400
Average per bushel	$0 78.4	$0 98.5	....	$1 07.3	$0 88.9
Ginseng:					
Pounds	20,067	....	....	....	....
Value	$29,315	....	....	....	....
Average per pound	$1 24.1	....	....	....	....
Total value to each country:					
1880	$17,491,052	$3,175,632	$4,667,801	$2,829,604	$6,367,284
1879	19,395,556	4,347,323	8,809,706	2,771,881	3,543,274

Articles.	British North America.	Mexico, Central and South America.	West Indies.	All other countries.	Totals.
Fruits, value	$208,430	$89,151	$55,249	$114,216	$2,090,634
Hemp and products, value	$37,468	$73,090	$88,775	$14,189	$1,272,451
Hops:					
Pounds	116,120	19,045	8,950	106,505	9,739,566
Value	$32,044	$5,632	$2,828	$20,193	$2,573,292
Average per pound	$0 27.6	$0 29.6	$0 31.6	$0 19.0	$0 25.4
Spirits:					
Gallons	4,923	902,555	31,364	1,347,524	11,418,506
Value	$8,484	$244,860	$15,448	$435,572	$3,027,545
Average per gallon	$1 72.3	$0 27.1	$0 49.2	$0 32.3	$0 26.5
Oil-cake:					
Pounds	506,091	132,736	6,703,060	5,728	453,023,225
Value	$6,284	$2,387	$125,525	$105	$6,259,827
Average per pound	$0 01.2	$0 01.8	$0 01.9	$0 01.8	$0 01.4
Oil, cotton-seed:					
Gallons	....	2,638	2,679	....	6,997,796
Value	....	$1,541	$1,200	....	$3,225,414
Average per gallon	....	$0 58.4	$0 44.8	....	$0 46.1
Seed cotton:					
Pounds	....	8,400	....	28,358	12,142,137
Value	....	$293	....	$652	$134,116
Average per pound	....	$0 03.5	....	$0 02.3	$0 01.1
Starch:					
Pounds	201,644	2,132,157	337,991	128,904	10,311,736
Value	$12,610	$84,219	$15,297	$9,499	$447,842
Average per pound	$0 06.2	$0 03.9	$0 04.5	$0 07.4	$0 04.3
Sugar, refined:					
Pounds	822,921	7,200,045	2,449,941	1,616,288	30,125,146
Value	$74,185	$640,236	$223,499	$150,364	$2,717,563
Average per pound	$0 09.0	$0 08.9	$0 09.1	$0 09.3	$0 09.0
Molasses:					
Gallons	83,015	959	957	2,400	3,596,010
Value	$32,186	$277	$320	$1,344	$539,603
Average per gallon	$0 37.6	$0 28.9	$0 33.4	$0 60.2	$0 15.0
Tobacco, leaf:					
Pounds	7,792,506	4,195,516	3,264,518	5,234,768	215,910,187
Value	$966,003	$417,691	$309,358	$515,115	$16,379,107
Average per pound	$0 12.4	$0 09.9	$0 09.4	$0 09.8	$0 07.6
Tobacco, manufactures, value	$61,461	$173,774	$176,179	$691,879	$2,053,166
Potatoes:					
Bushels	13,403	55,586	492,882	69,844	696,080
Value	$5,740	$37,828	$402,868	$24,983	$522,039
Average per bushel	$0 42.8	$0 68.0	$0 82.0	$0 35.8	$0 75.0
Ginseng:					
Pounds	....	....	....	371,016	391,083
Value	....	....	....	$503,727	$533,042
Average per pound	....	....	....	$1 35.8	$1 36.3
Total value to each country:					
1880	$1,444,886	$1,770,579	$1,416,546	$2,511,838	$41,768,641
1879	3,069,722	2,059,322	1,408,272	2,896,499	50,301,555

MARKET PRICES OF FARM

The following quotations represent, as nearly as practicable,

Products.	January.	February.	March.	April.	May.
NEW YORK.					
Flour:					
Superfine, State and Western ....bbl.	$5 00 to 5 85	$4 85 to 5 30	$5 20 to 5 50	$4 50 to 4 90	$4 25 to 4 75
Spring-wheat extras ..do..	5 90 to 7 50	5 50 to 7 25	5 60 to 7 25	5 00 to 6 50	4 80 to 6 50
Winter shipping extras ....bbl.	6 20 to 7 50	5 85 to 7 25	5 90 to 7 50	5 15 to 6 75	4 85 to 6 75
Minnesota patents ...do..	7 00 to 8 50	6 50 to 8 00	6 50 to 8 00	6 50 to 7 50	6 25 to 8 00
Southern extras and family ....bbl.	6 30 to 8 00	6 00 to 7 25	6 00 to 7 75	5 30 to 6 85	5 25 to 6 75
Wheat:					
Spring ....bush.	1 40 to 1 48	1 27 to 1 35	1 36 to 1 43	1 23 to 1 29	1 15 to 1 23
Amber winter ....do..	1 48 to 1 53	1 37 to 1 44	1 42 to 1 49	1 30 to 1 36	1 24 to 1 28
Red winter....do..	1 58 to 1 59	1 44 to 1 45	1 49 to 1 50	1 36 to 1 36½	1 27 to 1 28
White winter ....do..	1 46 to 1 56	1 34 to 1 42	1 42 to 1 48	1 25 to 1 32	1 20 to 1 24
Barley ....do..	72 to 1 05	70 to 1 00	66 to 1 05	62 to 1 05	62 to 1 05
Corn....do..	60 to 68	59 to 63	56 to 63	52 to 57	51 to 57
Oats ....do..	49 to 53	47 to 50	46 to 50	39 to 44	38 to 50
Rye....do..	96 to 98	90 to 93	95 to 98	88 to 92	87 to 90
Hay:					
Baled, first quality...ton.	16 00 to 17 00	17 00 to 18 00	18 00 to 19 00	17 00 to 19 00	17 00 to 20 00
Baled, second quality.do..	14 00 to 15 00	16 00 to 17 00	16 00 to 17 00	15 00 to 16 00	16 00 to 17 00
Beef:					
Mess....bbl.	9 50 to 10 50	9 50 to 10 00	9 00 to 10 00	9 50 to 10 50	9 00 to 9 75
Extra mess ....do..	11 00 to 11 50	10 75 to 11 00	11 00 to 11 50	11 00 to 11 50	10 50 to 11 00
Pork:					
Prime mess ....bbl.	11 00 to 11 50	13 00 to 13 50	12 50 to 13 00	12 00 to 12 25	11 00 to 11 50
Extra prime ....do..	10 50 to 11 00	10 25 to 10 50	10 00 to 10 50	9 75 to 10 00	9 50 to 10 00
Lard ....cental.	7 75 to 8 40	7 80 to 7 85	7 65 to 7 90	7 25 to 7 70	7 12 to 7 65
Butter:					
Western ....lb.	15 to 36	18 to 36	18 to 40	21 to 35	15 to 22
State ....do..	16 to 36	22 to 36	20 to 40	20 to 34	18 to 25
Cheese:					
State factory .... lb.	7 to 13¾	11 to 15	12 to 14½	12 to 14½	10½ to 14¼
Western factory ....do..	7 to 13	12 to 14¾	12 to 14½	12 to 14¼	10 to 14
Sugar, fair to prime refining....lb	7⅝ to 8	7½	7½ to 7¾	7⅝ to 8⅛	7⅝ to 7¾
Cotton:					
Ordinary to good ordinary ....lb.	10¾ to 11 15/16	11 1/16 to 11 9/16	11 5/16 to 12¼	11¼ to 12 3/16	9 13/16 to 10 13/16
Low middling to good middling....lb.	12¼ to 12⅞	12 7/16 to 13 3/16	12 11/16 to 13 7/16	12⅝ to 13⅜	11 7/16 to 12 3/16
Tobacco:					
Lugs....lb.	3½ to 6	3½ to 7½	3½ to 6	3½ to 6	3½ to 5¼
Leaf, common to good.do..	5½ to 10½	6½ to 10½	5 to 10½	5 to 10½	5 to 10
Wool:					
American XXX and picklock ....lb.	52 to 55	52 to 55	55 to 60	60 to 62	58 to 60
American X and XX.do..	44 to 53	43 to 53	46 to 57	50 to 57	49 to 56
American combing...do..	45 to 55	45 to 55	52 to 60	52 to 65	54 to 61
Pulled ....do..	43 to 57	30 to 57	30 to 57	33 to 62	33 to 55
California....do..	18 to 37	20 to 40	20 to 40	20 to 42	20 to 42
CINCINNATI.					
Flour:					
Superfine ....bbl.	4 25 to 5 40	4 50 to 5 00	4 50 to 4 85	3 90 to 4 40	3 75 to 4 00
Extra....do..	5 60 to 5 85	5 10 to 5 50	5 15 to 5 60	4 85 to 5 20	4 30 to 4 60
Family and fancy....do..	5 75 to 7 00	5 90 to 6 75	6 00 to 6 75	5 60 to 6 50	4 90 to 6 25
Wheat:					
Amber....bush.	1 34 to 1 35	1 27 to 1 28	1 30 to 1 31	1 20	1 13
White ....do..	1 38 to 1 40	....	1 35	....	1 15 to 1 16
Red winter ....do..	1 37 to 1 38	1 27 to 1 28	1 32 to 1 34	1 25 to 1 26	1 15 to 1 19
Corn....do..	40 to 41	42 to 44	40 to 43	40 to 44	40 to 45
Rye ....do..	91 to 93	80 to 85	84 to 86	80 to 81	81 to 82
Barley ....do..	60 to 87	63 to 90	60 to 80	62 to 80	65 to 95
Oats ....do..	39 to 43	39 to 42	36 to 40	37 to 40	35 to 37
Hay:					
Baled, No. 1 ....ton	16 00 to 17 00	18 00 to 19 00	15 00 to 16 00	16 00 to 16 50	16 00 to 17 00
Lower grades ....do.	13 00 to 15 00	14 00 to 16 00	13 00 to 14 00	13 00 to 15 00	13 00 to 15 00
Pork....bbl	12 75 to 13 00	12 75 to 13 00	12 00 to 12 25	10 50 to 11 25	10 25 to 10 50
Lard ....cental.	7 20 to 7 25	7 10 to 8 25	7 15 to 7 20	7 05 to 7 10	6 95 to 7 00
Butter:					
Choice ....lb.	24 to 25	23 to 25	26 to 28	27 to 30	20 to 22
Prime ....do..	18 to 21	18 to 20	23 to 25	23 to 25	15 to 18
Cheese, prime to choice factory....lb.	12 to 13½	13½ to 14	14 to 14½	12 to 14	11½ to 12½

PRODUCTS FOR 1880.

the state of the market at the beginning of each month.

June.	July.	August.	September.	October.	November.	December.
$3 75 to 4 30	$3 30 to 3 85	$2 50 to 4 25	$2 40 to 3 90	$2 75 to 4 00	$3 00 to 4 20	$3 60 to 4 50
4 10 to 6 50	3 85 to 6 25	4 15 to 6 50	3 75 to 6 00	4 00 to 6 25	4 30 to 6 50	5 00 to 6 75
4 75 to 6 75	4 15 to 6 50	4 65 to 6 50	4 00 to 6 25	4 15 to 6 50	4 40 to 6 75	5 30 to 7 00
6 25 to 8 00	5 50 to 7 50	6 50 to 8 75	6 00 to 8 25	6 00 to 8 25	6 50 to 8 50	7 00 to 9 00
5 00 to 7 00	4 40 to 6 50	4 85 to 6 75	4 60 to 6 50	4 70 to 6 50	5 00 to 6 75	5 60 to 7 75
1 09 to 1 20	1 01 to 1 09	1 00 to 1 08	94 to 1 02	1 00 to 1 08	1 12 to 1 17	1 14 to 1 23
1 22 to 1 28	1 12 to 1 18					
1 29 to 1 30	1 17 to 1 19	94 to 1 10	90 to 1 03	1 02 to 1 08	1 12 to 1 17	1 20 to 1 28
1 22 to 1 27	1 11 to 1 15	1 04 to 1 11	97 to 1 04	1 03 to 1 13	1 10 to 1 16	1 20 to 1 26
Nominal.			85 to 95	74 to 95	72 to 1 02	97 to 1 40
52 to 58	47 to 54	43 to 53	49 to 57	50 to 56	55 to 61	57 to 62
40 to 45	32 to 41	35 to 46	40 to 44	39 to 44	35 to 45	41 to 50
93 to 95	85 to 90	82 to 83	86 to 87	95 to 96	1 00 to 1 04	1 05 to 1 08
15 00 to 22 00	19 00 to 22 00	22 00 to 23 00	21 00 to 22 00	21 00 to 23 00	22 00 to 24 00	23 00 to 27 00
14 50 to 17 00	15 00 to 16 00	14 00 to 16 00	15 00 to 16 00	16 00 to 18 00	18 00 to 19 00	19 00 to 21 00
9 50 to 10 00	9 00 to 9 50	9 00 to 9 80	9 25 to 9 50	9 25 to 9 50	8 50 to 9 00	8 50 to 9 00
10 50 to 11 00	10 00 to 11 00	10 00 to 11 00	10 00 to 10 50	9 75 to 10 50	9 50 to 10 25	9 50 to 10 00
11 00 to 11 75	12 00 to 12 50	12 50 to 13 25	13 00 to 13 50	13 00 to 13 50	13 00 to 13 75	13 00 to 13 75
9 00 to 9 50	10 00 to 10 50	11 00 to 12 00	12 00 to 12 75	12 00 to 12 50	12 00 to 13 00	12 00 to 12 75
6 90 to 7 25	7 15 to 7 25	7 60 to 8 10	8 10 to 8 60	8 15 to 8 30	8 80 to 9 15	9 00 to 9 25
10 to 18	9 to 17	11 to 22	11 to 22	14 to 24	14 to 26	14 to 25
17 to 22	14 to 22	18 to 27	17 to 26	24 to 32	23 to 32	23 to 35
9 to 13	4 to 8¾	6 to 10¾	8 to 12½	8½ to 13½	10 to 13	10 to 13
9 to 11¾	4 to 6½	4 to 9½	8 to 12	8 to 12¾	8½ to 12½	8 to 12¾
7½ to 7¾	7⅝ to 7¾	7¾ to 8	7¾ to 8	7½ to 7¾	7⅝ to 7½	7½ to 7⅝
9 3/16 to 10 9/16	8 7/16 to 10 1/16	8 3/16 to 9 13/16	8⅞ to 10½	9⅛ to 10⅜	8 to 9¾	9 to 10⅝
11¼ to 12¼	11 3/16 to 12 7/16	10 15/16 to 12 3/16	11 7/16 to 12⅜	11⅜ to 12⅜	10½ to 11⅝	11 9/16 to 12⅝
4 to 6	4 to 6¼	4 to 6¼	4 to 6¼	3½ to 5¾	3½ to 5¾	3½ to 5¾
5½ to 10½	5½ to 10½	5½ to 10½	5 to 8	5 to 8	5 to 9	5 to 10
50 to 52	48 to 50	48 to 50	48 to 50	46 to 48	48 to 50	50 to 53
43 to 48	40 to 47	38 to 47	38 to 47	36 to 45	38 to 47	42 to 49
45 to 55	45 to 53	42 to 50	42 to 50	42 to 48	42 to 52	46 to 52
40 to 55	22 to 42	22 to 42	22 to 47	20 to 45	33 to 42	20 to 42
24 to 36	18 to 34	15 to 34	15 to 28	15 to 28	14 to 33	14 to 35
3 25 to 3 50	3 00 to 3 25	2 40 to 3 15	2 35 to 3 00	2 50 to 3 25	2 65 to 3 65	3 00 to 4 00
4 25 to 4 50	3 50 to 4 25	3 60 to 4 00	3 50 to 4 00	3 85 to 4 25	4 15 to 4 50	4 50 to 4 75
4 80 to 6 00	5 00 to 6 00	4 60 to 5 75	4 40 to 5 60	4 55 to 5 75	4 80 to 6 00	5 00 to 6 25
1 08	98 to 1 00	91 to 93	88 to 90	93 to 97	80 to 1 07	1 00 to 1 07
		92 to 97	90 to 93	93 to 98	1 05 to 1 08	1 06 to 1 08
1 12	1 00 to 1 02	95 to 97	92 to 94	94 to 99	1 05 to 1 06	1 06 to 1 08
40 to 42	37 to 43	39 to 42	43 to 45	43 to 48	36 to 44	46 to 48
80 to 85	72 to 75	68 to 70	83 to 84	89 to 90	89 to 90	98 to 1 00
95 to 97	75 to 83	80 to 90	75 to 90	70 to 90	65 to 93	70 to 1 00
34 to 38	28 to 33	30 to 34	31 to 33	32 to 35	30 to 35	35 to 39
14 50 to 15 00	14 00 to 15 00	16 00 to 17 00	12 00 to 13 00	14 50 to 15 50	15 00 to 16 00	15 50 to 16 50
13 00 to 14 00	12 00 to 13 00	14 00 to 15 00	10 00 to 11 00	12 00 to 13 00	13 00 to 14 00	14 00 to 15 00
10 50 to 11 00	11 75 to 12 25	14 50 to 15 00	15 75 to 16 00	17 00 to 18 50	13 75 to 14 00	13 00 to 15 00
6 45 to 6 50	6 50 to 6 60	7 25 to 7 50	7 65 to 8 00	7 80 to 7 95	8 10 to 8 15	8 50 to 8 65
18 to 19	15 to 16	17 to 19	17 to 25	22 to 25	22 to 25	22 to 27
13 to 15	12 to 13	14 to 15	15 to 22	14 to 21	18 to 21	20 to 25
9½ to 10	7 to 7½	9 to 9½	12 to 13	13 to 13½	12½ to 13	11 to 12½

MARKET PRICES OF FARM

Products.	January.	February.	March.	April.	May.
CINCINNATI—Continued.					
Sugar:					
New Orleans, fair to good ....lb.	$0 07¼ to $0 07⅜	$0 07½ to $0 07¾	$0 07½ to $0 07¾	....	$0 07¾ to $0 08
New Orleans prime ..do..	7½ to 8	8⅛ to 8¼	7⅞ to 8⅛	....	8⅛ to 8¼
Peanuts ....do..	3¾ to 5	3½ to 5¼	3½ to 5¼	$0 03½ to $0 05¼	3½ to 5¼
Cotton:					
Ordinary to good ordinary ....lb.	10⅝ to 11⅜	10½ to 11⅜	10⅞ to 11¾	10⅜ to 11⅜	9⅜ to 10⅝
Low middling to good middling ....lb.	11¾ to 12⅜	11⅞ to 12¾	12¼ to 13⅛	12⅛ to 13	11⅛ to 11⅞
Wool:					
Fleece, washed ....lb.	43 to 48	43 to 48	45 to 50	....	45 to 50
Tub-washed ....do..	45 to 52	45 to 52	45 to 55	....	40 to 50
Unwashed clothing..do..	32 to 37	32 to 37	32 to 37	....	30 to 36
Unwashed combing..do..	36 to 38	36 to 38	36 to 38	....	35 to 36
Pulled ....do..	43 to 45	43 to 45	50 to 52	....	42 to 45
CHICAGO.					
Flour:					
Winters ....bbl	6 00 to 7 00	6 85	5 75 to 6 75	5 75 to 6 00	....
Double extras..........do..	5 87 to 6 50	5 35 to 6 10	5 25 to 5 75	5 25 to 5 65	....
Superfines ....do..	4 50 to 5 00	....	....	3 62½ to 4 20	....
Wheat:					
Spring ....bush..	1 15 to 1 31	1 04 to 1 19	1 23 to 1 24	1 13 to 1 15	1 13 to 1 13½
Winter ....do..	1 20 to 1 32	1 03 to 1 22	1 13 to 1 25	1 08 to 1 11	1 08 to 1 09
Barley ....do..	53 to 65	53 to 80	40 to 65	54 to 75	60 to 80
Corn..........do..	36½ to 39⅞	34 to 37	35 to 37	34 to 35	36 to 36½
Oats ....do..	34 to 39	33 to 37	32 to 40	30 to 34½	29 to 30
Rye..........do..	80½ to 81	75 to 78	72 to 75	70 to 72	75 to 76
Hay:					
Timothy ....ton	13 50 to 14 25	13 00 to 14 50	12 00 to 13 50	11 50 to 12 50	12 00 to 14 50
Prairie..........do..	10 00 to 11 50	10 00 to 11 50	8 50 to 10 00	7 50 to 10 00	10 00 to 12 00
Beef:					
Mess..........bbl.	8 75 to 9 00	7 25 to 7 50	8 00 to 8 50	8 00 to 8 50	8 00 to 8 50
Extra mess ....do..	9 00 to 9 25	7 75 to 8 00	8 50 to 9 00	8 50 to 9 00	8 75 to 9 00
Hams..........do..	14 50 to 15 00	14 00 to 14 50	14 50 to 15 00	16 75 to 17 00	16 00 to 16 25
Pork, mess..........do..	13 00 to 13 30	12 20 to 12 25	11 65 to 11 85	10 60 to 10 75	10 05 to 10 20
Lard ....cental.	7 37½ to 7 45	7 27 to 7 30	7 10 to 7 15	6 95 to 7 00	7 00 to 7 02
Butter:					
Creamery ....lb.	28 to 33	28 to 33	32 to 37	31 to 36	21 to 24
Medium to choice dairy ....lb.	19 to 28	18 to 27	18 to 30	18 to 30	14 to 21
Cheese:					
Full creamery ....lb.	12 to 12¾	14¼ to 14¾	14½ to 15	13½ to 14½	14½ to 15
Part skim and low grades ....lb.	5 to 11¾	5 to 13	8 to 13	7 to 12	6 to 11¾
Sugar, New Orleans, fair to choice ....lb.	7⅞ to 8¼	7⅞ to 8⅜	7⅞ to 8⅛	....	....
Wool:					
Unwashed ....lb.	27 to 37	29 to 37	32 to 35	33 to 44	....
Fleece, washed ....do..	40 to 51	42 to 53	50 to 58	50 to 60	....
Tub washed..........do..	40 to 52	44 to 57	57 to 62	57 to 62	....
SAINT LOUIS.					
Flour:					
Fine and superfine ...bbl.	4 70 to 5 10	4 30 to 4 80	4 40 to 5 10	4 25	
X, XX, and XXX....do..	5 20 to 6 00	4 90 to 5 75	5 20 to 5 80	5 00 to 5 25	....
Family and fancy ....do..	6 10 to 6 65	5 80 to 6 25	5 85 to 6 50	5 60 to 6 00	4 90 to 5 25
Wheat:					
Winter ....bush.	1 21 to 1 37	1 15 to 1 25	1 21 to 1 30	1 10 to 1 25	1 07 to 1 11
Spring ....do..	....	....	....	1 01	....
Corn..........do..	35 to 36	34 to 39	34 to 38	34 to 36	32 to 36¾
Rye ....do..	75 to 80	72 to 78	70 to 75	72 to 75	68 to 74
Barley ....do..	....	60 to 70	58 to 73	55 to 70	55 to 75
Oats ....do..	37 to 38	37 to 37½	33 to 34	32 to 35	29½ to 32
Hay, timothy..........ton	16 00 to 17 00	17 00 to 18 00	14 00 to 16 00	15 00 to 16 50	15 00 to 17 00
Pork, mess..........bbl	13 75	12 75 to 13 50	12 25 to 12 50	....	10 50
Lard..........cental	8 10	7 25 to 8 00	7 75 to 8 00	6 60 to 7 75	7 25 to 7 50
Butter:					
Creamery ....lb.	28 to 33	32 to 35	30 to 35	30 to 35	23 to 25
Fair to choice dairy, packed ....lb.	18 to 25	18 to 26	16 to 28	22 to 29	18 to 22
Cheese:					
New York factory.....lb.	12½ to 13½	14 to 15	14 to 15	14 to 15	14 to 15
Ohio and Western....do..	12 to 13	13 to 14	13 to 14	11½ to 12½	11½ to 12½
Tobacco:					
Lugs ....lb.	3 to 7½	3 to 7½	3¼ to 7½	3¼ to 7½	3 to 7
Common to medium leaf..........lb.	5¼ to 7½	5 to 8½	5¼ to 7¾	4¾ to 7½	5 to 7½

PRODUCTS FOR 1880—Continued.

June.	July.	August.	September.	October.	November.	December.
$0 07 to $0 08	$0 07 to $0 08	$0 08 to $0 08¾	$0 08 to $0 08¾	$0 08¼ to $0 08¾	$0 07 to $0 07¾	$0 07 to $0 07⅛
8¼ to 8¾	8½ to 8¾	8¾ to 9	8½ to 9	9 to 9¼	7½ to 7¾	7¼ to 7¾
3¼ to 5	3¼ to 5	3¼ to 5	2½ to 4	2¾ to 5	2½ to 5	2⅝ to 5½
8¾ to 9⅞	8½ to 9¾	8 to 9¼	8¼ to 9½	8½ to 9¾	7⅞ to 9⅛	8¾ to 10⅛
10¾ to 11½	10⅞ to 11¾	10½ to 11½	10⅞ to 11⅞	10⅞ to 11⅝	10⅛ to 11	11⅛ to 12⅛
36 to 42	35 to 40	35 to 40	35 to 40	35 to 40	36 to 41	40 to 43
35 to 44	35 to 43	35 to 44	35 to 44	35 to 43	35 to 45	35 to 46
26 to 30	25 to 28	25 to 30	25 to 30	23 to 28	23 to 30	23 to 32
29 to 31	28 to 30	28 to 30	28 to 31	27 to 29	28 to 31	30 to 32
37 to 40	35 to 37	35 to 37	34 to 36	30 to 31	30 to 31	32 to 33
5 50	5 25 to 5 40	....	4 50 to 5 75	4 50 to 4 90	4 75 to 6 00	5 00 to 6 25
4 75 to 5 25	4 25 to 4 50	4 00 to 4 45	4 25 to 5 25	4 00 to 4 75	4 50 to 5 50	4 75 to 5 75
....	2 75 to 3 00	....	3 00 to 4 25	2 50 to 3 75	3 00 to 4 00	3 50 to 4 50
88 to 1 14	75 to 87½	89 to 94	89 to 94	85 to 94	91 to 1 02	91 to 1 09
97 to 1 14	91 to 92	88 to 97	92 to 96	92 to 95	95 to 1 03	94 to 1 09
65 to 75	63 to 74	73 to 75	58 to 75	61 to 77	48 to 96	51 to 1 07
35 to 38	32 to 34	35 to 38	38 to 41	38½ to 41	38 to 40	37 to 44
28 to 35	22 to 29	22 to 31	29 to 30	30 to 32	28 to 32	32 to 39
81 to 85	71 to 72	61 to 68	79 to 85	78 to 85	75 to 83	87 to 92
12 00 to 14 00	11 00 to 13 50	13 00 to 15 00	12 50 to 14 00	13 00 to 14 50	13 50 to 15 00	14 00 to 15 50
8 50 to 11 50	7 50 to 10 00	9 00 to 11 00	10 00 to 12 00	8 50 to 11 50	9 00 to 13 00	11 00 to 13 00
8 25 to 8 50	8 25 to 8 50	8 25 to 8 50	7 00 to 7 25	7 00 to 7 25	7 00 to 7 25	7 00 to 7 25
8 75 to 9 00	8 75 to 9 00	8 70 to 9 00	8 00 to 8 25	8 00 to 8 25	8 00 to 8 25	8 00 to 8 25
16 25 to 16 50	19 00 to 21 00	18 00 to 20 00	16 00 to 17 00	14 00 to 15 00	14 00 to 15 00	16 50 to 17 00
10 00 to 10 15	11 95 to 12 00	15 80 to 15 85	17 85 to 17 87	18 00 to 18 25	18 00 to 18 50	12 15 to 13 30
6 45 to 6 50	6 50 to 6 55	7 25 to 7 35	7 85 to 7 90	7 80 to 7 85	8 05 to 8 10	8 40 to 8 55
19 to 22	19 to 21	25 to 27	25 to 28	27 to 30	26 to 30	32 to 35
16 to 19	14 to 17	17 to 22	20 to 24	22 to 26	22 to 25	22 to 29
10 to 11	7 to 7½	9¼ to 9¾	12 to 12½	12½ to 13	12 to 13	11 to 12¾
4 to 9½	3 to 6½	5 to 8¼	6 to 11	6 to 12	6 to 11	4 to 10
....	....	....	....	....	....	....
20 to 28	20 to 28	20 to 31	20 to 31	20 to 31	20 to 31	21 to 32
40 to 42	30 to 36	34 to 41	36 to 42	36 to 41	36 to 41	35 to 42
43 to 46	40 to 46	39 to 50	39 to 48	39 to 48	39 to 48	39 to 50
....	2 40 to 2 85	2 40 to 3 00	2 25 to 2 80	2 60 to 3 15	2 70 to 3 25	2 85 to 3 25
....	2 90 to 4 50	3 15 to 4 50	2 90 to 4 20	3 25 to 4 35	3 05 to 4 40	3 30 to 4 60
....	4 70 to 5 40	4 60 to 5 35	4 30 to 5 20	4 50 to 5 40	4 60 to 5 50	4 80 to 5 70
1 02 to 1 12	97 to 98	83 to 91	80½ to 99	87 to 95	88 to 1 00	1 16 to 1 30
32 to 36	34 to 35	33 to 34	32 to 36	38 to 43	37 to 39	34 to 36
72 to 80	73 to 75	59 to 61	70 to 75	79 to 84	83 to 85	86 to 90
....	55	....	85	62 to 85	83 to 93	70 to 90
29 to 31½	25 to 29	22 to 26	26 to 30	29 to 30	27 to 29	33 to 34
11 00 to 13 25	11 00 to 12 00	11 00 to 13 00	13 00 to 15 00	13 00 to 15 00	13 00 to 16 00	15 00 to 17 00
10 65 to 11 25	13 75 to 14 00	15 25 to 15 75	15 75 to 16 55	16 00 to 17 00	14 00 to 15 25	13 50 to 14 25
7 37 to 7 50	6 75 to 7 50	8 25 to 8 35	7 35 to 7 75	8 37 to 8 75	8 00 to 8 75	8 20 to 9 50
17 to 21	18 to 20	22 to 28	25 to 27	28 to 30	29 to 31	30 to 35
10 to 17	12 to 18	16 to 22	18 to 23	20 to 26	18 to 25	24 to 30
10 to 11	12 to 13	11 to 12	13 to 14	14 to 15	14 to 15	14 to 15½
9 to 10	8 to 10	9 to 10	9 to 12	10 to 14	10 to 13	11 to 12½
3 to 7	3 to 7	3 to 7	3½ to 8	3½ to 8	3½ to 8	3½ to 8
5 to 8½	5 to 7½	5 to 7½	4¾ to 7½	4¾ to 7½	4¾ to 8	4¾ to 7½

MARKET PRICES OF FARM

Products.	January.	February.	March.	April.	May.
SAINT LOUIS—Continued.					
Wool:					
Unwashed....lb.	$0 25 to $0 35	$0 25 to $0 35	$0 25 to $0 37	$0 28 to $0 38	$0 20 to $0 35
Tub-washed....do..	45 to 54	45 to 56	50 to 60	53 to 62	40 to 52
NEW ORLEANS.					
Flour:					
Superfine....bbl.	5 50 to 5 75	4 75 to 5 00	5 00 to 5 25	4 50 to 4 75	3 00
Extras....do..	5 75 to 6 87½	5 12 to 6 20	5 50 to 6 50	4 75 to 5 75	4 00 to 5 00
Choice to fancy....do..	7 25 to 9 00	6 50 to 6 75	6 62 to 6 88	6 12 to 6 50	5 37 to 5 87
Wheat:					
Winter....bush.	....	1 40	1 40 to 1 45	1 36	1 23
Spring....do..	....	....	....	....	....
Corn....do..	59 to 60	50 to 54	50 to 54	49 to 51	43 to 45
Oats....do..	54 to 55	50 to 51	44 to 45	41 to 42	41 to 42
Hay:					
Prime....ton.	22 50	23 00 to 24 00	23 00 to 24 00	18 00 to 20 00	21 00
Choice....do..	25 00	26 00 to 27 00	27 00 to 28 00	20 00 to 22 00	22 00
Beef:					
Western mess....bbl.	12 00 to 13 00	11 50 to 12 50	11 50 to 12 50	11 50 to 12 50	11 50 to 12 50
Fulton market...half bbl.	8 75 to 9 00	8 50 to 8 75	8 50 to 8 75	8 25 to 8 50	8 25 to 8 50
Pork, mess....bbl.	13 00 to 13 25	13 25 to 13 50	12 50 to 13 00	11 75	11 12 to 11 25
Lard....cental.	8 25 to 9 00	7 50 to 8 00	7 25 to 8 75	7 00 to 8 50	7 25 to 8 50
Butter:					
N. Y. prime to choice...lb.	21 to 36	21 to 35	24 to 30	24 to 28	25 to 30
Western prime to choice....lb.	23 to 36	24 to 35	24 to 30	19 to 22	18 to 30
Cheese:					
Western factory....lb.	12 to 13	14	13 to 14	11 to 13	13 to 14
N. Y. cream....do..	16	16	15 to 16	16 to 17	16 to 17
Sugar:					
Fair to fully fair....lb.	6⅝ to 7⅜	7⅛ to 7⅜	6⅝ to 7¼	7⅜ to 7¾	7⅜ to 7⅜
Prime to strictly prime....lb.	7½ to 7⅞	7½ to 7⅝	7⅜ to 7⅞	8 to 8¼	7¾ to 8
Clarified....do..	8¼ to 9⅛	8⅜ to 9¼	8½ to 9⅛	8⅜ to 9¼	8⅜ to 9¼
Cotton:					
Low ordinary....lb.	....	10⅜ to 10⅞	10½ to 10¾	10⅛ to 10⅜	8⅞ to 9
Ordinary to good ordinary....lb.	10⅝ to 11	11 to 11¾	11 to 11⅞	10⅝ to 11¾	9⅜ to 10⅝
Low middling to good middling....lb.	11½ to 12⅛	12 to 12⅞	12⅜ to 13¼	12⅛ to 13⅛	11¼ to 12¼
Middling fair....do..	13	13¼ to 13⅝	13½ to 13¾	13¼ to 13⅝	12½ to 12¾
Tobacco:					
Lugs....lb.	3¼ to 4⅜	3½ to 5	3½ to 5	3½ to 5	3½ to 5
Leaf, low to medium..do..	5 to 7¼	5¼ to 7¼	5¼ to 7¼	5¼ to 7¼	5¼ to 7¼
Wool:					
Louisiana clear....lb.	30 to 34	29 to 30	25 to 30	35 to 38	31 to 33
Lake....do..	33 to 36	32 to 34	30 to 34	40 to 42	33 to 36
SAN FRANCISCO.					
Flour:					
Superfine....bbl.	4 25 to 5 50	4 00 to 4 50	4 00 to 4 50	4 00 to 4 50	3 75 to 4 00
Extra....do..	6 00 to 6 50	5 25 to 5 50	5 25 to 5 50	5 25 to 5 50	4 50 to 5 50
Fancy....do..	6 50 to 6 75	6 00 to 6 25	6 00 to 6 25	6 00 to 6 26	5 75 to 6 00
Wheat:					
California....cental.	1 75 to 2 10	1 75 to 2 00	1 75 to 2 00	1 75 to 1 95	1 50 to 1 65
Oregon....do..	1 75 to 2 05	1 75 to 2 00	1 75 to 1 95	1 75 to 1 95	1 50 to 1 60
Barley....do..	65 to 1 00	65 to 95	70 to 95	80 to 95	70 to 90
Corn....do..	90 to 1 00	90 to 1 00	1 00 to 1 15	1 05 to 1 10	1 10 to 1 35
Oats....do..	1 15 to 1 35	1 15 to 1 35	1 15 to 1 35	1 25 to 1 35	1 25 to 1 65
Hay....ton.	8 00 to 13 50	8 00 to 13 50	8 00 to 12 50	8 00 to 12 50	7 00 to 13 50
Pork:					
Mess....bbl.	15 00 to 15 50	15 00 to 15 50	15 00 to 15 50	15 00 to 15 50	15 50 to 16 25
Prime mess....do..	11 00 to 12 50	11 00 to 12 50	11 00 to 12 50	11 00 to 12 50	12 00 to 12 50
Beef:					
Mess....do..	8 00 to 8 50	8 00 to 8 50	8 00 to 8 50	8 00 to 8 50	9 00 to 10 00
Family mess....half do..	7 00 to 7 50	7 00 to 7 50	7 00 to 7 50	7 00 to 7 50	8 00
Lard....lb.	7½ to 9	7½ to 9½	7 to 8	7 to 9	8 to 10
Butter:					
Overland....do..	12½ to 15	12½ to 15	12½ to 15	14 to 15	14
California....do..	20 to 30	20 to 26	20 to 26	20 to 26	16 to 18
Oregon....do..	14 to 15	14 to 15	14 to 15	14 to 15	14 to 15
Cheese....do..	14 to 16	14 to 16	14 to 16	14 to 16	14 to 16
Wool:					
Native....do..	15 to 16	15 to 16	15 to 20	25 to 30	20 to 25
California....do..	16 to 33	16 to 33	16 to 35	30 to 35	25 to 28
Oregon....do..	18 to 38	18 to 33	20 to 35	30 to 35	25 to 28

PRODUCTS FOR 1880—Continued.

June.	July.	August.	September.	October.	November.	December.
$0 17 to $0 30	$0 18 to $0 29	$0 20 to $0 30	$0 23 to $0 27	$0 16 to $0 28	$0 16 to $0 28	$0 17 to $0 31
34 to 45	33 to 45	37 to 48	37 to 45	33 to 46	33 to 46	33 to 49
3 00 to 3 25	3 00 to 3 25	3 00 to 3 25	3 00 to 3 25	2 75 to 3 00	3 00 to 3 50	3 25 to 4 00
3 50 to 4 75	3 50 to 4 75	3 50 to 4 75	3 50 to 4 75	3 25 to 4 60	3 75 to 5 00	4 00 to 5 25
5 25 to 5 87	5 25 to 5 80	5 25 to 5 75	5 25 to 5 75	5 10 to 5 65	5 50 to 6 10	5 85 to 6 35
1 20	1 07	1 05	1 03 to 1 05	1 04 to 1 07	1 13 to 1 14	1 16 to 1 18
44 to 46	47 to 50	45 to 48	46 to 47	49 to 53	52 to 53	70 to 72
43 to 44	34 to 35	36 to 37	40 to 42	55 to 60	42 to 65	48 to 62
18 00 to 20 00	15 00 to 16 00	17 00 to 19 00	17 00 to 18 50	17 00 to 18 00	21 00 to 22 00	26 00 to 27 00
22 00 to 23 00	18 00 to 19 00	18 00 to 20 00	18 00 to 20 50	20 50 to 21 00	23 00 to 24 00	28 00 to 29 00
10 00 to 10 50	10 00 to 10 25	11 25 to 11 50	10 00 to 11 50	10 50 to 11 00	9 00 to 11 00	9 50 to 11 00
7 75 to 8 00	7 50 to 7 75	7 50 to 7 75	7 25 to 7 50	[illegible] 50 to 7 75	7 00 to 7 75	8 25 to 8 50
11 00 to 11 25	12 75 to 13 00	14 80 to 15 25	16 25 to 16 50	17 25 to 18 00	15 25 to 15 50	14 00 to 14 50
7 50 to 8 00	7 50 to 8 50	8 00 to 8 25	8 50 to 9 25	8 50 to 9 25	8 75 to 9 25	9 00 to 10 25
21 to 25	16 to 19	20 to 22	20 to 28	20 to 28	20 to 27	23 to 33
16 to 20	14 to 17	15 to 21	15 to 23	18 to 28	15 to 26	18 to 27
7 to 11	7 to 10	5½ to 11	8½ to 12	12 to 14	10 to 13	8 to 13½
14 to 15	12 to 13	13 to 15	15 to 15½	15 to 16	15 to 16	15½ to 16
7⅜ to 7⅝	7¾ to 8½	....	....	8½ to 8¾	5½ to 7	6⅛ to 6⅝
7¾ to 8	8⅝ to 8¾	....	....	8¾ to 9	7 to 7¼	6¾ to 7
8½ to 9⅛	8¾ to 9½	9⅜ to 9⅞	10¼ to 10¾	9¼ to 9½	7½ to 8¾	7¾ to 8¾
8 to 8¼	8⅛ to 8⅜	7½ to 7¾	7⅜ to 7⅝	7½ to 7¾	7⅜	8 to 8¼
8⅝ to 10	8⅞ to 10¼	8⅜ to 10	8⅛ to 9¾	8½ to 10	8¼ to 9⅜	9 to 10¼
10⅝ to 12	10⅞ to 12½	10¾ to 12¼	10⅜ to 11½	10½ to 12	10⅛ to 11⅝	10⅞ to 12⅝
12⅝ to 12½	12¾ to 13	12⅝ to 12⅞	11⅞ to 12	12¼ to 12½	12⅛	13 to 13¼
3½ to 5	3½ to 5	4 to 5	4½ to 4¾	4½ to 4¾	4½ to 4¾	4½ to 4¾
5¼ to 7¼	5¼ to 7¼	5 to 7	5¼ to 7	5¼ to 7	5¼ to 7	5¼ to 7
25 to 28	28	29 to 30	27 to 28	25 to 27	25 to 28	26 to 27
29 to 30	30	31 to 31½	32 to 35	27 to 29	28 to 30	28 to 30
3 50 to 4 00	3 50 to 4 00	3 50 to 4 00	3 25 to 3 75	2 87 to 3 50	3 50 to 4 25	3 50 to 4 25
5 00 to 5 50	5 00 to 5 50	5 00 to 5 50	4 50 to 5 00	4 50 to 5 00	4 75 to 5 00	4 75 to 5 50
....	....	....	....	....	5 25 to 5 50	5 50 to 5 75
1 50 to 1 65	1 50 to 1 60	1 50 to 1 60	1 25 to 1 45	1 00 to 1 42	1 25 to 1 50	1 30 to 1 55
1 50 to 1 60	1 50 to 1 60	1 42 to 1 45	1 25 to 1 40	1 35 to 1 40	1 35 to 1 50	1 40 to 1 55
70 to 90	65 to 85	65 to 85	75 to 90	75 to 90	75 to 95	1 00 to 1 20
1 15 to 1 35	1 10 to 1 40	1 10 to 1 40	1 05 to 1 10	95 to 1 00	95 to 1 10	1 10 to 1 20
1 25 to 1 65	1 35 to 1 50	1 35 to 1 50	1 35 to 1 50	1 35 to 1 50	1 15 to 1 25	1 15 to 1 45
6 00 to 13 00	6 00 to 12 00	6 00 to 12 00	8 00 to 13 00	8 00 to 12 50	9 00 to 14 00	10 00 to 17 00
16 00 to 17 00	20 00	20 00	20 00	20 00	20 00	20 00
12 00 to 12 50	12 00 to 12 50	12 00 to 12 50	12 00 to 12 50	12 00 to 12 50	12 00 to 12 50	12 00 to 12 50
9 00 to 10 50	9 00 to 10 50	10 00 to 12 00	10 00 to 12 00	10 00 to 12 00	10 00 to 11 00	10 00 to 11 00
8 00	8 00	7 00 to 8 00	7 00 to 7 50	7 00 to 7 50	7 00 to 7 50	7 00 to 7 50
9 to 10	10 to 10½	10 to 11	10 to 10½	10 to 12	10 to 12	10 to 12¼
14	14	14	14 to 16	18 to 20	20 to 25	23 to 25
16 to 18	16 to 20	16 to 25	16 to 27	20 to 35	30 to 40	35 to 45
14 to 15	14 to 16	14 to 15	14 to 15	16 to 18	20 to 25	20 to 25
14 to 16	14 to 16	14 to 16	14 to 16	13 to 16	13 to 16	13 to 16
18 to 22	18 to 22	18 to 22	18 to 22	16 to 25	10 to 20	12 to 20
29 to 30	20 to 32	20 to 35	29 to 32	20 to 28	20 to 26	20 to 28
20 to 30	20 to 32	20 to 35	20 to 32	20 to 28	20 to 26	20 to 28

LIVE-STOCK

Products.	January.	February.	March.	April.	May.
NEW YORK.					
Cattle:					
Extra beeves......cental.	$11 00	$10 25 to $10 50	$10 75	$10 50 to $10 75	$9 75 to $10 00
Good to fair..........do..	$10 00 to 10 50	8 00 to 10 00	$9 75 to 10 00	9 75 to 10 25	9 00 to 9 50
Poor to common .....do..	8 00 to 9 00	7 00 to 7 50	7 50 to 7 75	7 75 to 8 25	7 00 to 7 50
Milch cows.........head.	35 00 to 55 00	35 00 to 55 00	32 00 to 50 00	30 00 to 45 00	30 00 to 40 00
Veal calves ....cental.	5 50 to 8 50	6 50 to 8 50	6 00 to 8 50	5 25 to 7 50	4 25 to 6 25
Sheep..................do..	4 50 to 6 25	5 00 to 6 50	5 00 to 7 75	6 00 to 7 50	4 50 to 5 50
Swine..................do..	5 25 to 5 50	4 75 to 5 00	4 80 to 5 10	4 60 to 4 85	4 65 to 4 85
CINCINNATI.					
Cattle:					
Fair to good shipping steers ....cental.	4 25 to 5 00	4 50 to 5 25	4 00 to 4 85	4 00 to 4 75	4 00 to 4 65
Common to choice butcher's grades ......cental.	1 50 to 4 00	2 00 to 4 25	1 75 to 4 50	2 00 to 4 40	2 00 to 4 50
Cows and heifers.....do..	3 00 to 3 75	3 35 to 4 00	3 50 to 4 25	3 50 to 4 25	3 60 to 4 35
Sheep..................do..	2 50 to 4 75	3 00 to 5 25	3 50 to 5 50	3 50 to 6 00	3 50 to 6 00
Swine..................do..	3 65 to 4 50	3 90 to 4 75	3 50 to 4 75	3 50 to 4 75	3 25 to 4 50
CHICAGO.					
Cattle:					
Extra beeves......cental.	5 00 to 5 25	5 00 to 5 50	5 00 to 5 40	5 00 to 5 40	4 60 to 4 85
Choice beeves ....do..	4 60 to 4 75	4 50 to 4 75	4 50 to 4 75	4 40 to 4 65	4 25 to 4 40
Good to medium grades, cental................	3 50 to 4 40	3 75 to 4 40	3 75 to 4 40	3 80 to 4 35	3 80 to 4 15
Poor to common grades, cental................	2 25 to 3 15	2 30 to 3 50	2 60 to 3 75	2 60 to 3 75	3 00 to 4 00
Veal calves ....cental.	2 75 to 4 75	2 75 to 4 75	3 00 to 5 00	3 00 to 5 25	3 00 to 5 25
Sheep..................do..	3 50 to 5 00	4 25 to 5 75	4 25 to 5 75	4 75 to 6 25	6 00 to 6 80
Swine..................do..	3 50 to 4 70	4 35 to 4 65	4 15 to 4 55	3 50 to 4 80	3 50 to 4 50
SAINT LOUIS.					
Cattle:					
Choice natives ....cental.	4 90 to 5 10	5 25 to 5 50	5 15 to 5 35	5 10 to 5 25	5 00 to 5 15
Fair to prime ....do..	4 00 to 4 80	3 50 to 5 15	4 20 to 5 00	4 25 to 4 90	4 25 to 4 90
Fair to good butcher's steers.......... cental.	3 50 to 4 15	3 50 to 4 25	3 50 to 4 00	3 50 to 4 15	3 50 to 4 25
Common to good stock steers...........cental	2 75 to 3 50	2 75 to 3 50	2 50 to 3 60	3 00 to 3 40	2 50 to 3 40
Oxen..................do..	3 00 to 3 50	3 00 to 3 75	3 00 to 3 75	3 00 to 4 00	3 00 to 3 25
Milch cows.........head.	14 00 to 50 00	14 00 to 50 00	14 00 to 50 00	14 00 to 50 00	14 00 to 50 00
Calves ....do..	5 00 to 9 00	5 00 to 9 00	5 00 to 9 00	5 00 to 9 00	5 00 to 9 00
Sheep ....cental.	2 45 to 4 50	2 25 to 5 25	2 25 to 6 00	2 75 to 6 00	2 75 to 6 00
Swine..................do..	4 15 to 4 75	3 50 to 4 65	3 45 to 4 60	3 90 to 4 55	3 25 to 4 25
Horses:					
Good plugs ....head	25 00 to 40 00	25 00 to 40 00	25 00 to 30 00	35 00 to 50 00	35 00 to 50 00
Southern ....do..	30 00 to 70 00	30 00 to 70 00	40 00 to 75 00	50 00 to 75 00	50 00 to 80 00
Streeters.............do..	80 00 to 100 00	80 00 to 100 00	80 00 to 100 00	80 00 to 95 00	80 00 to 100 00
Draft ....do..	90 00 to 125 00	90 00 to 125 00	90 00 to 125 00	90 00 to 125 00	90 00 to 125 00
Mules:					
14 to 15 hands high..head.	50 00 to 70 00	55 00 to 65 00	65 00 to 80 00	65 00 to 80 00	70 00 to 95 00
15 to 16 hands high ..do..	75 00 to 145 00	85 00 to 150 00	90 00 to 120 00	85 00 to 130 00	95 00 to 130 00
16 to 16½ hands high..do..	150 00 to 170 00	160 00 to 215 00	115 00 to 160 00	150 00 to 170 00	160 00 to 180 00
NEW ORLEANS.					
Cattle:					
Corn-fed beeves...cental.	2 50 to 5 50	2 00 to 5 00	2 00 to 5 00	2 50 to 5 50	2 50 to 5 50
Grass-fed beeves ...head	12 00 to 35 00	10 00 to 30 00	10 00 to 30 00	10 00 to 30 00	10 00 to 30 00
Milch cows ....do..	35 00 to 80 00	35 00 to 80 00	35 00 to 80 00	35 00 to 80 00	25 00 to 80 00
Calves ....do..	7 00 to 9 00	5 00 to 7 00	5 00 to 7 00	6 00 to 9 00	6 00 to 9 00
Sheep..................do..	2 00 to 4 00	2 00 to 4 00	2 00 to 4 00	2 00 to 4 00	2 00 to 5 00
Swine ....cental.	3 00 to 4 50	3 50 to 4 50	2 50 to 5 00	2 50 to 5 00	2 50 to 5 00
Horses:					
Common............head.	50 00 to 90 00	50 00 to 90 00	50 00 to 90 00	50 00 to 90 00	50 00 to 90 00
Good work...........do..	90 00 to 110 00	90 00 to 120 00	90 00 to 120 00	90 00 to 100 00	90 00 to 120 00
Saddle and harness ..do..	120 00 to 225 00	125 00 to 200 00	125 00 to 225 00	120 00 to 200 00	120 00 to 225 00
Mules:					
Small and common..head.	75 00 to 110 00	75 00 to 105 00	75 00 to 105 00	75 00 to 110 00	75 00 to 110 00
Medium ....do..	135 00 to 150 00	135 00 to 155 00	135 00 to 155 00	135 00 to 150 00	135 00 to 150 00
Firstclass for city use.do..	180 00 to 200 00	160 00 to 200 00	160 00 to 200 00	160 00 to 185 00	175 00 to 200 00
Plantation ....do..	165 00 to 190 00	....	150 00 to 185 00	140 00 to 165 00	140 00 to 185 00
Rice culture ....do..	105 00 to 140 00	105 00 to 135 00	105 00 to 135 00	100 00 to 140 00	100 00 to 140 00

MARKETS.

June.	July.	August.	September.	October.	November.	December.
$0 25 to $10 00	$9 75 to $10 00	$9 50 to $10 00	$8 00 to $10 00	$8 50 to $10 50	$11 00 to $11 25	$10 50 to $11 00
9 00 to 9 25	7 50 to 9 50	7 00 to 8 25	7 75 to 8 50	8 00 to 9 00	7 50 to 10 25	8 25 to 9 75
7 00 to 7 25	6 75 to 7 25	6 50 to 7 00	7 00 to 8 00	7 50 to 8 50	7 00 to 8 00	7 25 to 7 75
35 00 to 45 00	28 00 to 48 00	25 00 to 55 00	30 00 to 45 00	35 00 to 50 00	30 00 to 50 00	30 00 to 50 00
4 00 to 6 00	4 00 to 6 00	4 50 to 6 50	4 50 to 6 50	5 00 to 7 50	5 00 to 7 50	6 00 to 8 00
4 00 to 5 20	3 50 to 5 25	3 25 to 4 75	4 25 to 5 25	5 00 to 5 35	3 60 to 5 50	4 00 to 5 50
Nominal	4 75 to 4 85	5 25 to 5 35	5 40 to 5 50	5 50 to 5 60	4 50 to 4 85	4 50 to 4 85
4 00 to 4 60	4 00 to 4 60	4 00 to 4 75	4 00 to 4 75	4 00 to 4 50	3 85 to 4 30	3 90 to 4 50
1 75 to 4 40	1 75 to 4 35	1 75 to 4 25	1 50 to 4 25	1 75 to 4 10	1 75 to 4 00	1 75 to 4 00
3 65 to 4 30	3 60 to 4 25	3 40 to 4 15	3 40 to 4 10	3 35 to 4 00	3 35 to 3 90	3 35 to 3 90
2 50 to 4 25	2 50 to 4 25	2 25 to 4 65	2 25 to 4 50	2 50 to 4 75	2 50 to 4 75	2 50 to 4 50
3 25 to 4 45	3 25 to 4 40	3 75 to 4 95	3 90 to 5 15	4 00 to 5 35	3 75 to 4 75	3 90 to 4 70
4 50 to 4 60	4 65 to 4 90	4 65 to 4 85	5 15 to 5 50	5 30 to 5 65	5 25 to 5 65	5 75 to 6 25
4 25 to 4 35	4 00 to 4 60	4 40 to 4 55	4 70 to 5 00	4 80 to 5 15	4 60 to 5 00	5 00 to 5 50
3 75 to 4 15	2 50 to 3 50	3 80 to 4 35	3 75 to 4 50	3 50 to 4 60	3 40 to 4 40	3 50 to 4 75
3 00 to 3 85	2 00 to 2 25	2 75 to 3 50	2 60 to 3 50	2 50 to 3 25	2 50 to 3 15	2 50 to 3 15
3 50 to 6 00	3 50 to 5 75	4 00 to 6 00	4 00 to 6 00	4 00 to 5 00	3 50 to 5 50	3 50 to 5 50
3 25 to 4 75	3 00 to 4 25	4 15 to 4 65	3 65 to 4 50	3 25 to 4 50	3 00 to 4 50	2 75 to 4 50
3 75 to 4 15	4 00 to 4 45	4 40 to 4 75	3 90 to 5 60	4 00 to 5 45	4 35 to 4 85	3 50 to 4 75
4 50 to 4 60	4 65 to 4 80	4 65 to 4 75	4 75 to 4 90	5 10 to 5 30	5 10 to 5 40	5 25 to 5 50
4 00 to 4 40	4 20 to 4 60	4 20 to 4 60	4 25 to 4 65	4 50 to 5 00	4 50 to 5 00	4 25 to 5 10
3 40 to 3 90	3 90 to 4 15	3 50 to 4 00	3 50 to 4 00	3 65 to 4 30	3 65 to 4 30	3 65 to 4 25
2 50 to 3 40	2 50 to 3 90	2 50 to 3 40	2 25 to 3 20	2 25 to 3 20	2 25 to 3 20	2 25 to 2 90
3 00 to 3 60	3 00 to 3 60	3 00 to 3 40	3 00 to 3 40	3 00 to 3 40	3 00 to 3 40	3 00 to 3 40
13 00 to 30 00	13 00 to 32 00	13 00 to 32 00	13 00 to 32 00	13 00 to 32 00	15 00 to 35 00	15 00 to 45 00
5 00 to 9 00	5 00 to 8 00	5 00 to 8 00	5 00 to 8 00	5 00 to 8 00	5 00 to 8 00	5 00 to 9 00
2 75 to 5 75	2 25 to 4 00	2 80 to 4 00	2 25 to 4 00	2 25 to 4 00	2 25 to 4 00	2 25 to 4 25
3 60 to 4 25	4 15 to 4 35	3 80 to 5 00	3 20 to 5 10	3 00 to 5 35	3 50 to 4 65	4 15 to 4 85
35 00 to 50 00	35 00 to 50 00	20 00 to 30 00	20 00 to 30 00	20 00 to 40 00	20 00 to 40 00	20 00 to 40 00
50 00 to 85 00	50 00 to 85 00	40 00 to 90 00	45 00 to 90 00	50 00 to 90 00	50 00 to 60 00	75 00 to 110 00
70 00 to 90 00	70 00 to 90 00	70 00 to 90 00	75 00 to 100 00	75 00 to 110 00	75 00 to 110 00	75 00 to 110 00
130 00 to 175 00	130 00 to 175 00	125 00 to 175 00	130 00 to 175 00	130 00 to 175 00	130 00 to 175 00	130 00 to 175 00
70 00 to 95 00	70 00 to 95 00	65 00 to 85 00	60 00 to 85 00	60 00 to 95 00	60 00 to 95 00	60 00 to 100 00
85 00 to 130 00	85 00 to 130 00	100 00 to 125 00	100 00 to 140 00	105 00 to 140 00	105 00 to 150 00	110 00 to 150 00
150 00 to 175 00	150 00 to 175 00	140 00 to 175 00	160 00 to 175 00	150 00 to 180 00	160 00 to 180 00	160 00 to 180 00
2 00 to 5 00	2 00 to 5 00	2 00 to 5 00	2 00 to 5 00	....	....	....
10 00 to 30 00	12 00 to 35 00	12 00 to 35 00	12 00 to 35 00	12 00 to 35 00	10 00 to 35 00	10 00 to 30 00
25 00 to 80 00	25 00 to 65 00	25 00 to 80 00	25 00 to 80 00	25 00 to 65 00	25 00 to 65 00	25 00 to 75 00
6 00 to 9 00	6 00 to 9 00	6 00 to 9 00	6 00 to 9 00	6 00 to 9 00	6 00 to 10 00	6 00 to 9 00
2 00 to 5 00	2 00 to 5 00	2 50 to 5 00	2 00 to 5 00	2 00 to 4 00	2 00 to 3 50	2 00 to 3 00
2 50 to 5 50	2 50 to 5 00	2 50 to 5 00	2 50 to 5 50	2 50 to 5 25	2 50 to 5 00	2 50 to 5 00
50 00 to 90 00	50 00 to 90 00	50 00 to 90 00	60 00 to 90 00	60 00 to 100 00	60 00 to 100 00	60 00 to 100 00
90 00 to 120 00	90 00 to 120 00	90 00 to 120 00	90 00 to 125 00	100 00 to 140 00	100 00 to 140 00	100 00 to 140 00
125 00 to 200 00	125 00 to 200 00	125 00 to 200 00	125 00 to 250 00	125 00 to 250 00	125 00 to 250 00	125 00 to 250 00
75 00 to 105 00	75 00 to 105 00	75 00 to 105 00	75 00 to 110 00	85 00 to 120 00	85 00 to 120 00	85 00 to 120 00
130 00 to 155 00	135 00 to 155 00	135 00 to 155 00	140 00 to 165 00	150 00 to 175 00	150 00 to 175 00	150 00 to 175 00
160 00 to 185 00	160 00 to 185 00	160 00 to 185 00	200 00 to 225 00	210 00 to 235 00	210 00 to 235 00	210 00 to 235 00
150 00 to 175 00	150 00 to 175 00	150 00 to 175 00	165 00 to 200 00	175 00 to 210 00	175 00 to 210 00	175 00 to 210 00
100 00 to 135 00	100 00 to 135 00	100 00 to 135 00	110 00 to 140 00	120 00 to 150 00	120 00 to 150 00	120 00 to 150 00

PORK PACKING.

The following statistics have been compiled from the annual report of the Cincinnati Price Current. The packing year consists of a summer season, from March 1 to November 1, and a winter season, from November 1 to March 1. The importance of the summer season for operation in pork packing is increasing, and during the summer of 1880 there was the usual gain over the year previous that has been noted since five years. The great pork-producing region of the country is in

THE WEST.

SUMMER PACKING.—The summer season of 1880 commenced with an abundant supply of hogs, and packing progressed more rapidly than in any previous season.

The number packed, weight per head, and yield of lard, during the last five years, was as follows:

Season.	Numbers.	Aggregate net weight.	Average net weight per head.	Aggregate yield of lard.	Average yield of lard per head.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
1876	2, 307, 866	424, 879, 300	184. 10	70, 040, 980	30. 35
1877	2, 543, 120	484, 553, 471	190. 57	85, 364, 176	33. 56
1878	3, 378, 044	631, 807, 730	187. 03	113, 940, 500	33. 73
1879	4, 051, 248	743, 525, 500	183. 53	129, 580, 672	31. 98
1880	5, 323, 898	983, 109, 336	184. 66	163, 197, 754	30. 65

The numbers packed at the six leading cities, Chicago, Saint Louis, Cincinnati, Indianapolis, Milwaukee, and Louisville, together with other prominent points, during the last five years, were as follows:

Packing points.	1876.	1877.	1878.	1879.	1880.
Chicago	1, 315, 402	1, 508, 026	2, 017, 841	2, 155, 418	2, 971, 127
Saint Louis	131, 158	148, 277	142, 000	350, 000	410, 000
Cincinnati	121, 173	134, 416	154, 517	149, 934	110, 556
Indianapolis	283, 621	204, 264	312, 224	243, 500	383, 165
Milwaukee	60, 827	54, 785	107, 053	67, 537	136, 619
Louisville	9, 500	19, 800	25, 000	25, 000	30, 000
All other	386, 185	473, 552	619, 409	1, 059, 859	1, 282, 431
Total	2, 307, 866	2, 543, 120	3, 378, 044	4, 051, 248	5, 323, 898

WINTER PACKING.—The season beginning November 1 opened with the price of pork about $1 per 100 pounds more than the previous year. The price subsequently fell, and the average price during the winter was 45 cents per 100 pounds higher than the preceding winter. The numbers packed, the weight per head, and the yield of lard, for the last five years, are as follows:

Season.	Numbers.	Aggregate net weight.	Average net weight per head.	Aggregate weight of lard.	Average lard per head.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
1876	5, 101, 308	1, 101, 478, 090	215. 92	173, 877, 890	34. 08
1877	6, 505, 446	1, 470, 506, 963	226. 04	251, 193, 500	38. 61
1878	7, 480, 648	1, 624, 351, 264	217. 14	294, 752, 358	39. 40
1879	6, 950, 451	1, 480, 068, 518	212. 94	252, 439, 188	36. 32
1880	6, 919, 456	1, 437, 252, 660	207. 71	246, 667, 145	35. 65

The numbers packed at the six leading cities, Chicago, Cincinnati, Saint Louis, Indianapolis, Milwaukee, and Louisville, together with other points, during the last five years, were as follows:

Packing points.	1876.	1877.	1878.	1879.	1880.
Chicago	1, 618, 084	2, 501, 285	2, 943, 115	2, 525, 219	2, 781, 064
Cincinnati	523, 576	632, 302	623, 584	534, 559	522, 425
Saint Louis	414, 747	509, 540	629, 261	577, 793	474, 159
Indianapolis	294, 198	270, 150	472, 455	364, 021	388, 763
Milwaukee	225, 598	371, 982	444, 221	340, 783	325, 729
Louisville	214, 862	279, 414	187, 506	231, 259	231, 269
All other	1, 810, 243	1, 940, 773	2, 180, 506	2, 376, 817	2, 211, 646
Total	5, 101, 308	6, 505, 446	7, 480, 648	6, 950, 451	6, 919, 456

The following is a detailed exhibit of the number of hogs packed in the winter season since three years, by States:

States.	1878–'79.	1879–'80.	1880–'81.
Ohio	932, 878	914, 964	839, 440
Indiana	682, 321	604, 186	540, 554
Illinois	3, 214, 869	2, 784, 754	2, 979, 190
Iowa	569, 703	658, 085	643, 816
Missouri	965, 830	926, 931	962, 968
Kansas	132, 346	137, 780	42, 212
Nebraska	80, 658	57, 481	102, 197
Minnesota	18, 450	32, 990	32, 500
Wisconsin	472, 108	388, 726	375, 557
Michigan	132, 976	120, 394	92, 814
Kentucky	312, 412	256, 463	233, 842
Tennessee	40, 561	42, 897	39, 867
Miscellaneous	25, 500	24, 800	29, 000
Total	7, 480, 648	6, 950, 451	6, 919, 456

SUMMER AND WINTER CONSOLIDATED.—For the twelve months ending March 1 the numbers of hogs packed in the West during five years are as follows:

Years.	Summer.	Winter.	Total.
1876–'77	2, 307, 866	5, 101, 308	7, 409, 174
1877–'78	2, 543, 120	6, 505, 446	9, 048, 566
1878–'79	3, 378, 044	7, 480, 648	10, 858, 702
1879–'80	4, 051, 248	6, 950, 451	11, 001, 699
1880–'81	5, 323, 898	6, 919, 456	12, 243, 354

IN THE EAST.

The following table shows the receipts of live and dressed hogs received during the last three years, both winter and summer seasons included, on the Atlantic coast:

Cities.	1878–'79.	1879–'80.	1880–'81.
Boston	537, 310	610, 183	738, 424
New York	1, 839, 962	1, 806, 919	1, 808, 079
Philadelphia	348, 835	467, 000	482, 100
Baltimore	392, 654	391, 524	371, 867
Total	3, 118, 761	3, 275, 626	3, 400, 470

Interior cities.—The number packed in three interior cities of New York, during the year, was: Albany, 20,000; Troy, 15,000; Buffalo, 278,536; total, 313,536.

PACIFIC SLOPE.

California.—There was some increase in the number of hogs packed in California in 1880, compared with the preceding year, and the total was larger than any year since 1874. San Francisco continues to do the largest part of the packing, and operations are carried on throughout the year at this point.

The number packed at San Francisco, and the estimated number in other parts of the State, were 325,000, against 290,000 last year. The number packed in Oregon cannot be obtained, but it is estimated at 75,000 in 1880 against 80,000 in 1879.

RECAPITULATION.

The total number of hogs packed in the United States during the last five years is as follows:

Section.	1876-'77.	1877-'78.	1878-'79.	1879-'80.	1880-'81.
The West	7, 409, 174	9, 048, 566	10, 858, 692	11, 001, 699	12, 243, 354
The East	2, 551, 239	2, 703, 670	3, 222, 011	3, 524, 546	3, 714, 006
The Pacific Slope	305, 000	310, 000	400, 000	370, 000	400, 000
Total	10, 265, 413	12, 062, 236	14, 480, 703	14, 896, 245	16, 357, 360

WEIGHTS PER BUSHEL IN THE SEVERAL STATES.

In the annual report of this department for the year 1871 will be found a digest of the laws of the several States regulating the weight per bushel of the different articles produced and consumed in those States.

In the report for 1877 there is published a table of such weights rectified and brought to that date.

In reply to many inquiries for the facts contained in that table, it is again, with such changes as have been made, presented below in Table No. 1. In Table No. 2 is given the value of foreign coins, as estimated by the Director of the United States Mint, for the use of officials of the United States. In Table No. 3 are given the weights and measures of the principal foreign countries with which we have commerce. The pound is avoirdupois in all cases.

No. 1.—*Legal weight per bushel, in pounds.*

States.	Apples, dried.	Barley.	Beans, castor.	Beans, white.	Bran.	Buckwheat.	Coal.	Corn, ear.	Corn, shelled.	Corn-meal.	Hair.	Lime, unslaked.	Malt, barley.	Onions.	Oats.	Peaches.	Potatoes, Irish.	Potatoes, sweet.	Pease.	Rye.	Salt.	Blue-grass seed.	Clover seed.	Flax seed.	Hemp seed.	Hungarian-grass seed.	Millet seed.	Osage-orange seed.	Sorghum seed.	Timothy seed.	Turnips.	Wheat.
Maine		48		64		48			56					52	30		60		60	50											50	60
New Hampshire				60					56	50					32		60		60	56												60
Vermont		48	60	60		46			56					52	32		60		60	56			60							45	60	60
Massachusetts																																
Rhode Island		48							56	50				50	32		60			56												
Connecticut		48		60		48			56	50				50	32		60		60	56											50	60
New York		48		a62		48			58								60		60	56			60	55						44		60
New Jersey	25	48	60	60		50			56					57	30	33	60	54	60	56			64	55								60
Pennsylvania						48			56						30		56			56	b85		62									60
Delaware*									56	c48																						60
Maryland	28	48	60	60		48	80	70	56	48	7		34	56	32	d40	60	56	62	56		14	64	56	44	48	50	33		45	56	60
Virginia	28	48		60		52	80	70	56	50	8	80	38	57	32	d40	60	56	60	56	50	14	60	56	44	48	50	34		45	55	60
North Carolina																																
South Carolina																																
Georgia	24	47		60	20	52	80	70	56	48	8	80		57	32	e38	60	55	60	56		14	60	56	44					45	55	60
Florida*																																
Alabama*																																
Mississippi																																
Louisiana																																
Texas*																																
Arkansas*																																
Tennessee*																																
West Virginia	25	48		60		52	80		56						32	33	60			56			60	56						45		60
Kentucky	24	47	45	60	20	55	76	70	55	50	8	35		57	32	39	60	55	60	56	50	14	60	56	44	50	50			45	60	60
Ohio	22	48		60		50	80	f70	56			70	34	50	32	33	60	50	60	56			60	56	44	50	50			45		60
Michigan	22	48	46	60		48	80	70	56	50		70		54	32	28	60	56	60	56	56	14	60	56	44	50	50	33		45	58	60
Indiana	25	48	66	60		50	g80	68	56	50				48		33	60			56	50	14	60		44					45		60
Illinois	24	48	46	60	20	52	80	70	56	48	8	80	38	57	32	33	60	55		56	h55 / 50	14	60	56	44					45	55	60
Wisconsin	28	48				50			56				48		32	28	60			56			60	56						46		60
Minnesota	28	48				42			56						32	28	60			56			60									60
Iowa	24	48	46	60	20	52	80	70	56			80		57	32	33	60	46		56	50	14	60	56	44	45	45	32	30	45		60
Missouri	24	48	46	60	20	52	80		56					57	32	33	60			56	50	14	60	56	44					45		60
Kansas	24	48	44	60	20	50	80	70	56	50	8	80	32	57	32	33	60	50		56	50	14	60	54	44	50	50			45	55	60
Nebraska	24	48	46	60	20	52	80	70	56	50	8	80	30	57	34	33	60	50	60	56	50	14	60	56	44	60	40	32	30	45	55	60
California*		50				40			52						32					54												60
Oregon																																
Nevada																																
Colorado		48		60		52	80	70	56	50		80		57	32		60			56	80	14	60		44					45		60

* The standard adopted by the United States. *a* Disregarded in practice; sales of beans being made at 60, and of corn at 56. *b* Foreign; coarse, 85; ground, 70; fine, 62. *c* Sifted, 44. *d* Unpeeled. *e* Unpeeled, 33. *f* After the 1st of January following its production, 68. *g* Mined within the State. *h* Fine, 55; coarse, 50.

In a few instances the weights established by law of agricultural products not enumerated in the table were reported. *Apples:* In Maine, 44 pounds; Vermont, 46; Michigan, Iowa, and Missouri, 48. *Beets:* In Maine, Vermont, and Connecticut, 60 pounds. *Carrots:* In Maine and Vermont, 50 pounds; Connecticut, 55. *Parsnips:* In Connecticut, 45 pounds. *Berries:* In Rhode Island, 32 pounds. In Iowa, cherries, grapes, currants, and gooseberries, 40 pounds; blackberries, strawberries, and raspberries, 32; peaches and quinces, 48; broom-corn seed, 30. In Michigan, dried plums, 28 pounds; cranberries, 40. In Michigan and Virginia, orchard-grass seed, 14 pounds; in former, red-top seed, 14; in latter, 12; pea-nuts, 22; chestnuts, 57. In Wisconsin, rape-seed, 50 pounds. In Indiana, Kansas, and Nebraska, hay, 2,000 pounds per ton. In Maryland, bran, 2,240 pounds per ton.

The following legalized measures were also reported: In Rhode Island, a cask of lime is to contain 31½ gallons. In New Hampshire, a measure for charcoal is to contain 2 bushels, and shall not be less than 20 inches in diameter, and deep enough to hold 18 gallons; milk is to be sold by wine-measure. In Pennsylvania, the standard bushel for bituminous coal and for coke is to contain 2,688 cubic inches, even measure; for charcoal, 2,571 cubic inches. In Wisconsin, "the half bushel, and the parts thereof, shall be the standard measure for charcoal; fruits and other commodities sold by heaped measure shall, in being measured by the half bushel or smaller measure, be heaped as high as may be without special effort or design." In Missouri, the standard bushel for coke and charcoal is to contain 2,680 cubic inches; apple-barrels, length, 28½ inches; chines, ¾ of an inch at ends; diameter of head, 17¼ inches; inside diameter at the center of the barrel, 20½ inches. In Kansas, "in the sale of charcoal, fruits, vegetables, and all other articles sold by the heaped measure, 1,282 cubic inches shall constitute a half bushel."

No. 2.—*Estimate of values of foreign coins.*

Country.	Monetary unit.	Standard.	Value in U. S. money.
Austria	Florin	Silver	$0 40.7
Belgium	Franc	Gold and silver	19.3
Bolivia	Boliviano	Silver	82.3
Brazil	Milreis of 1,000 reis	Gold	54.6
British Possessions in North America	Dollar	Gold	1 00
Chili	Peso	Gold and silver	91.2
Cuba	Peso	Gold and silver	93.2
Denmark	Crown	Gold	26.8
Ecuador	Peso	Silver	82.3
Egypt	Piaster	Gold	04.9
France	Franc	Gold and silver	19.3
Great Britain	Pound sterling	Gold	4 86.6½
Greece	Drachma	Gold and silver	19.3
German Empire	Mark	Gold	23.8
India	Rupee of 16 annas	Silver	39
Italy	Lira	Gold and silver	19.3
Japan	Yen	Silver	88.8
Liberia	Dollar	Gold	1 00
Mexico	Dollar	Silver	89.4
Netherlands	Florin	Gold and silver	40.2
Norway	Crown	Gold	26.8
Peru	Sol	Silver	82.3
Portugal	Milreis of 1,000 reis	Gold	1 08
Russia	Rouble of 100 copecks	Silver	65.8
Sandwich Islands	Dollar	Gold	1 00
Spain	Peseta of 100 centimes	Gold and silver	19.3
Sweden	Crown	Gold	26.8
Switzerland	Franc	Gold and silver	19.3
Tripoli	Mahbub of 20 piasters	Silver	74.3
Turkey	Piaster	Gold	04.4
United States of Colombia	Peso	Silver	82.3
Venezuela	Bolivar	Gold and silver	19.3

No. 3.—*Weights and measures of foreign countries as used in commerce, with equivalents in measures and weights of United States.*

Weights and measures.	Country.	Equivalent United States measure.
Almude	Portugal and Spain	4½ gallons.
Arroba	Portugal and Brazil	32 pounds 12 ounces.
	Spain and Mexico	25 pounds.
	Spain (liquid measure)	4.25 gallons.
Barile	Naples and Leghorn	12 gallons.
Canay	Ceylon	545 pounds.
	Bombay	560 pounds.
	Madras	500 pounds.
Cantar	Malta and Sicily	175 pounds.
	Leghorn (oil)	88 pounds.
Catty	China (tea)	1⅓ pounds.
Chetwert	Russia	5.95 bushels.
Fanega	Spain and Mexico	1.6 bushels.
	Buenos Ayres	3.7 bushels.
Hectoliter	France	2.84 bushels.
Kilogram	France	2.20 pounds.
Last	Bremen (grain)	80 bushels.
	Hamburg (grain)	89 bushels.
	Sweden (grain)	75 bushels.
	Portugal (salt)	70 bushels.
Lispound	Berlin and Hamburg	17 pounds.
Mark	Holland	½ pound, or 8 ounces avoirdupois.
Maund	Bengal	85 pounds.
	Bengal (English factory)	75 pounds.
	Bombay (spices)	28 pounds.
Pfund	Austria and Bavaria	1.2 pounds.
	Bremen and Denmark	1.1 pounds.
Pecul	Batavia and Madras	135 pounds.
Quarter	England (grain)	8 bushels.
Quintal	Spain	96 pounds.
Shippound	Holland	368 pounds.
Stone	England	14 pounds.
	England (fish and meat)	8 pounds.
Vara	Spain and Mexico	33 inches.
Werst	Russia	3,501 feet.

EUROPEAN STATISTICS.

The following agricultural returns of the Kingdom of Great Britain are taken from the report of Mr. R. Giffen, chief of the statistical department of the Board of Trade, London:

The total quantity of land returned in 1880 as under all kinds of crops, bare, fallow, and grass, amounted for Great Britain to 32,102,000 acres. For Ireland the returns obtained by the registrar-general show a total of 15,358,000 acres, and for the Isle of Man and Channel Islands the totals are respectively 97,000 acres and 30,000 acres.

Thus for the whole of the United Kingdom the cultivated area was, in 1880, 47,587,000 acres, exclusive of heath and mountain pasture land, and of woods and plantations.

In Great Britain the area returned as under cultivation has increased by 126,000 acres since 1879, and the total increase in the ten years since 1870 is no less than 1,694,000 acres. Of this increase, about two-thirds, or 1,187,000 acres, were in England, 220,000 acres in Wales, and 287,000 acres in Scotland.

Looking at the details of the various crops in Great Britain, I have to notice that the area under wheat in 1880 was 2,909,000 acres, or 19,000 acres more than in the previous year. The wheat area of 1879 was, however, the lowest on record since the returns were first obtained in 1867, and the present year's crop was grown on nearly 591,000 acres less than in 1870. In some countries it is stated by the collecting officers that a favorable autumn led to an increased breadth of wheat being sown, but the large number of unlet farms, and of farms where agricultural depression prevailed, appears to have caused much wheat land to be left in fallow, as will be noticed presently. In barley there is a considerable decrease since 1879, when 2,667,000 acres were sown, as compared with only 2,467,000 acres in the present year. The inferior quality and the difficulty of securing the crop last year are stated by the officers in some places as having caused this decrease, but it may be noted that the present year's acreage under barley is fully equal to the average of the last ten years.

Oats were sown on 2,797,000 acres, or an increase of 5 per cent. over the area in 1879, and these figures have only once been reached since 1867; but the other stock-feeding corn crops show a considerable falling off, beans being grown on 427,000 acres,

as compared with 530,000 acres in 1870, and pease on 234,000 acres, against 317,000 in 1870. The imports of maize, which compete largely with these crops, have somewhat declined during the past year, but are still more than double those of ten years ago. Taking, then, all the figures as to the corn crops in Great Britain, we find their area was 8,876,000 acres, or a decrease of rather more than 1 per cent. from the previous year, and of 7 per cent. from the year 1870.

As regards the green crops, we find an increase of 10,000 acres planted with potatoes, and the area, 551,000 acres, is nearly equal to the figure of ten years ago. Turnips and swedes were returned as grown on 2,024,000 acres, a small increase from 1879, but mangolds show a decrease of nearly 6 per cent. from last year; cabbage, kohl-rabi, &c., of 4 per cent.; and vetches, lucerne, and other green crops of more than 15 per cent.; the acreage this year being only 380,000, making the total area under green crops 3,477,000 acres, or 2 per cent. less than in 1879. Green crops, on the whole, have shown little change during the last ten years, but the present year's figures are less than in any year since 1868. Flax has increased somewhat from the average of the last five years, but the area, 9,000 acres, is still less than half the acreage grown ten years ago. Hops were planted on 67,000 acres—about the same area as in 1879.

Bare fallow in Great Britain has further increased from 721,000 acres to 812,000 acres, and has this year taken a larger area than in any year since 1870, when there were only 610,000 acres in fallow. The depression in agriculture and the number of farms unlet and temporarily farmed by their owners are stated by the collecting officers as the chief reasons of so much land being uncropped, and the foul state of the land is also noticed in some districts.

Orchards in Great Britain again show a satisfactory increase, their acreage being this year returned as 180,000 acres, against 175,000 in 1879 and 165,000 in 1878. Market gardens have also increased from 41,000 acres to 44,000 acres, and the collectors report both with regard to orchards and market gardens that there is a growing demand for fruit and vegetables, especially in the neighborhood of towns. The uncertainty of the climate for fruit-growing must always, however, tend to restrict the extension of fruit plantations except in naturally favored districts.

Turning now to the various kinds of live stock, there appears to be a slight decline in agricultural horses, caused, it is stated, by the number of unlet farms, and also a decrease in brood mares and young horses, for which the demand has not been so great recently. Moreover, the stock of horses had increased up to last year, when the numbers were larger than in any year since 1870. The imports of horses from abroad were 26,000 in 1878, 15,000 in 1879, and only 6,600 in the first eight months of the present year. As regards horned cattle, milch cows have decreased less than 1 per cent., but other cattle show an increase of nearly 2 per cent., so that the total number of horned cattle in Great Britain is, this year, 5,912,000, as compared with 5,856,000 in 1879. Sheep in the country have suffered an important decline of nearly a million, chiefly owing, the collectors state, to the losses by disease; and lambs have also decreased more than half a million, partly, it is stated, from the weak condition of the ewes. The stock of sheep and lambs is now only 26,619,000, which appears to be a very insufficient number, considering the additional permanent pastures of late years. It may be remarked that these great losses in sheep and lambs have occurred only in England and Wales, the counties of Scotland with few exceptions showing a small increase in sheep and a considerable one in lambs, while the northern border counties of England have also escaped in great measure. Pigs have further decreased by 91,000 since 1879, and by 483,000 since 1878, the competition of American bacon being stated to make pig-keeping less profitable than formerly, while, as before mentioned, the sanitary regulations in populous places tend also to diminish their numbers.

Turning now to the figures of the crops and live stock in Ireland, we find that the changes are of much the same nature as those in the returns for Great Britain. The cultivated area is slightly larger than in the two last years, being this year 15,358,000 acres, as against 15,336,000 acres in 1879, and 15,345,000 acres in 1878. It is true that before 1877 the cultivated area averaged 400,000 acres more than these figures, but the apparent decline was caused by a separate heading being made in the return of 1877 for "barren mountain land," some of which had often in previous years been included under the head of "grass," in consequence of having some live stock on it when the returns were collected. As regards corn crops in Ireland, there is little change to notice from 1879, the increase in the acreage of oats counterbalancing the decrease in wheat and barley.

There has, however, been a considerable decline in the area of corn crops since 1870, when they covered 2,173,000 acres, as compared with 1,766,000 at the present time. Coming to green crops, we notice a further general decline in the acreage of almost all the crops. Potatoes were planted in 821,000 acres, against 843,000 acres in 1879, and 1,044,000 acres in 1870. Turnips occupied 303,000 acres, against 315,000 acres last year, and the total acreage of green crops amounts to less than a million and a quarter, as compared with a million and a half ten years ago. Flax was grown on 157,000 acres, or 24 per cent. more than in 1879. Rotation grasses show a small decline, and permanent grasses an increase, the area now amounting to 10,261,000 acres.

As regards live stock, we find a decrease in every description from 1879, but as regards horses and cattle the number are still fully equal to those of ten years ago. In sheep, however, the decrease of nearly 500,000 from last year leaves the number little over 3,500,000, and pigs too are less by 20 per cent., there being now only 849,000, against 1,072,000 in 1879, and 1,459,000 in 1870.

AUSTRALIA.

It appears from the various colonial accounts that 2,750,000 acres of land in Australasia were under wheat in the last harvest; being two and a half times the area under wheat there ten years ago, and within 300,000 acres of the wheat acreage of the United Kingdom.

The produce, moreover, which last year was only 10 bushels per acre, was this year more than 13 bushels, or about the average produce in the United States, the largest wheat-growing colony (South Australia) yielding 10 bushels to the acre, Victoria 13 bushels, and New Zeland as much as 28 bushels. Barley is not yet an important crop in Australia, but its acreage was this year 136,000, against 80,000 in 1879, Victoria and New Zealand having both doubled their area under barley, and the produce averaged 25 bushels per acre. Oats were grown on 565,000 acres, and yielded about 31 bushels per acre, the produce of New Zealand averaging nearly 40 bushels an acre. Maize is grown almost entirely in New South Wales and Queensland. The area under that crop in the former colony was 135,000 acres in the present year, and the produce 35 bushels to the acre, or nearly 6 bushels more than in the United States.

Potatoes occupied 103,000 acres, and the produce was 418,000 tons, or more than four tons to the acre, the average yield in New Zealand being between 5 and 6 tons.

There is little change in the acreage under vineyards in Australia of late years, 13,000 acres being this year under vineyards, from which 1,800,000 gallons of wine were made. About 17,000 gallons of wine were imported into the United Kingdom from Australia in 1879, and New Zealand and Tasmania also consumed some of the surplus produce of the wine-making colonies.

As regards live stock in Australia, in the absence of this year's returns for two important colonies, Queensland and New Zealand, we are unable to make a very close comparison with past years, but in Victoria we find a small falling off in cattle and a larger one, nearly three-quarters of a million, in sheep, the number of sheep in Victoria being now less than in any year since 1864. The decrease in the number and acreage of squatting runs of late years, owing to more land being cultivated, is no doubt the chief cause of this decline.

In New South Wales, on the other hand, there is an increase from last year's figures in all descriptions of stock, and especially in sheep, of which there are now 29,000,000, or double the number in 1870.

The approximate number of live stock in the whole of Australasia for the present year was, of horses, 1,050,000; horned cattle, 7,510,000; sheep, 65,400,000; and pigs, 810,000.

ROUMANIA.

The following account of agricultural methods and customs is taken from the report of Consul-General Schuyler to the Department of State, and may be found of interest as illustrative of the cultivation of the country bordering on the Black Sea and the Danube River, which has been, since many years, the granary from which Western Europe drew supplies of grain in times of failure in their home crops.

In 1873, the latest year for which we have any statistics, the cultivated land in the principality was divided as follows:

	Acres.
Maize (Indian corn)	3,196,000
Wheat	2,480,000
Barley	880,000
Rye	259,000
Oats	248,000
Buckwheat	11,000
Millet and small grains	226,000
Dry vegetables	250,000
Potatoes	1,000
Kitchen and market gardens	455,000
Hemp	13,000
Flax	6,000
Tobacco	5,000
Vines	255,000

The average annual agricultural production of Roumania is estimated as follows:

Maize (Indian corn)	bushels	42,397,000
Wheat	do	28,543,000
Barley	do	10,059,000
Rye	do	3,029,000
Oats	do	1,543,000
Millet	do	2,507,000
Buckwheat	do	177,000
Beans and lentils	pounds	18,672,000
Potatoes	do	51,378,000
Hemp	do	4,985,000
Flaxseed	do	1,683,000
Tobacco	do	1,978,000
Wine	gallons	35,000,000

The meadows and pasture lands in Roumania are estimated to cover six and a half million acres, and the average yearly production of hay is valued at two million tons.

As to the agricultural methods employed in Roumania, I allow myself to quote the following passages from an article which recently appeared in the London Times. This article was written by Mr. E. M. Grant, an American civil engineer, who has resided in Roumania for some time, and who has given the subject the most careful attention. He obtained much of his information by direct correspondence with trustworthy persons throughout the country, and his statements can, I think, be thoroughly relied on:

"The greater part of the plowing done in Roumania is performed with the primitive implements used by the ancestors of the present proprietors, and which are little more than a curved branch of a tree with a piece of iron as a point to penetrate the earth. The natural effect of such a plow is, of course, to break up the ground, turn over half of it, and push aside the other half in lumps, which are left unturned, instead of a clean, smooth furrow, as left by the modern implement, which insures a fresh surface turned up to the light and heat of the sun at each plowing.

"The peasants say that these rude utensils can easily be repaired, as they always carry the simple tools which are necessary for this purpose; whereas, if the cast-iron or steel land-sides or mold-boards of the modern plow are broken they must send long distances to have them replaced. This objection could be met by establishing village depots for the sale of these parts of a plow, and also by sending duplicates with each implement sold; but, as these rural depots have not yet been established, there still remains a good deal of force in the peasant's reasoning. The large proprietors, however, especially in Moldavia, have introduced large numbers of modern plows. Some English plows are used in the country, but the greater part of those imported come from Austria.

"The farmers assert that the English plows are not adapted to their country, and that they are too heavy for the easily-worked soil of Roumania, and require too much expenditure of animal labor in hauling them. English makers, if they desire to secure a trade in the East, should send out practical experts to study the nature of the soil and the wants of the people, so as to be able to produce an implement suitable for the market. There are five steam plows in Roumania, but their great cost, difficulty of making repairs, want of regular systems of drainage to remove soft, wet places in the fields, which serve as traps to imbed the unwieldy machines, and the weak bridges, which are incompetent to bear the weight of the apparatus when being transported from one locality to another, all combine to render the prospect of the steam plow becoming a prominent feature in Roumanian agricultural operations a very precarious one for the next half century at least.

"There are no barns for storing unthrashed grain in the principality; hence the newly-cut crops are stacked in immense piles near the village; and as the old way of thrashing by treading out the grain with horses was both slow and wasteful, the steam thrashers forced themselves upon the proprietors by their own merits and the necessity of getting the grain out of the straw during the fine weather which always succeeds the harvesting season in this quarter of Europe.

"The thrashers go from village to village, and are now so generally distributed that nearly all the grain grown in this country is thrashed by machinery. Mr. Lee has delivered 150 steam thrashing machines of English manufacture, and he states that nearly all of those in use in Roumania are made in England.

"A large proportion of them are the property of persons who enter the business as a speculation, thrashing the grain for a percentage or for a sum of money.

"The use of harrows is by no means universal in Roumania. In their absence the seed is sometimes covered by the time-honored custom of dragging a tree-top behind a pair of bullocks, which answers the purpose tolerably well when the land is very mellow and free from lumps, stones, or old stubble. Where neither of these systems

is in vogue, the seed is sown broadcast before the land is plowed, and the plow, therefore, covers it with the furrow. This is the general custom in Bulgaria. The use of drills or sowing machines is coming into fashion, as it will be seen above, 188 of them being used in the principality in 1877; but with these machines the land should be harrowed beforehand in order to insure the smooth and even planting of the seed. The amount of seed sown per acre in Roumania is excessive; and, in fact, it is nearly double in quantity that used in the United States. This naturally enough detracts to a serious extent from the legitimate profits of the farmer, as the surplus is not only wasted, but the crowding of the stalks of grain interferes with their proper growth. This wasteful system of seeding probably came in vogue before the process of harrowing was invented, and when the grain was sown broadcast and then plowed under with the primitive implements already described. The half furrow, half lumpy action of this plow, left a large portion of the seed exposed to view, and it was picked up by the birds. Another portion was so deeply buried that it never came to the surface. Old customs cling to life with wondrous tenacity, and it is probably to the above facts that Roumania farming owes its wasteful system of planting crops.

"The amount of seed used for the principal grains grown in this country is as follows: Wheat, 2 bushels 27 quarts per acre; rye, 2 bushels 27 quarts; barley, 3 bushels 10 quarts; oats, 3 bushels, 10 quarts; maize, 13 quarts; buckwheat, 26 quarts; millet and other small grains, 13 quarts per acre. The cultivation of the crops of maize and potatoes (which need considerable care between the planting and the harvest) is very slack. There is none of the "shovel plows" used by all the farmers in America for clearing the weeds and grass from the spaces between the rows, which render the hoe nearly useless, so perfect is their operation. The peasants use heavy, awkward hoes, of native manufacture, and, as the labor of raising this cumbrous implement for a chopping cut is no slight one, the number of such cuts per day is not very extensive, and, as a natural consequence, there is much choking of the crops by weeds and a proportionate reduction in the product of the land. In handling the hay and other crops, the laborers use wooden forks, made from forked brushwood, which enable them to take up about one-half the quantity raised by a farm hand in America with light steel-pronged forks with hickory handles. In digging the potatoes, when the crop has matured, awkward iron shovels, made by gypsy smiths, take the place of the five-pronged, light steel "potato-hook" used universally in the United States—an implement which digs twice as fast as a shovel, and cuts and mars the potatoes themselves very much less than its gypsy-made predecessor. When reaping-machines are not used in cutting the grain crops, the old fashioned sickle is employed.

"The self-binding reaping machine is looked forward to by the proprietors here as the means of securing their crops in good season in future, as the peasants generally refuse to hire themselves to bind behind a reaping machine of the old style. They insist upon being employed to cut the grain as well as to bind and 'shock' it. This unaccountable peculiarity in the labor question in Roumania has prevented the more general introduction of reaping machines. The self-binders will also enable the proprietors to raise much larger areas of grain, as at the present time their operations are seriously curtailed on account of the great difficulty of procuring harvest hands at the proper time, in order to secure the crops in the best possible condition."

CONCLUSION.

In conclusion, I would respectfully call your attention to the fact that the business of this division is increasing each year. The demands of the public press and agricultural associations are increasing not only in numbers but in variety of inquiries, and I would suggest that the force of the division and scope of the investigations made by us be materially increased. The value of lands, the rate of wages, and the market facilities of the different sections of the country are matters that require a much more thorough investigation than we have been able to give to them.

The monthly report of the condition of the crops and the investigations made for members of Congress and other persons interested in agriculture have been made as usual, and the work of the office has been satisfactorily done by the efficient clerks under my charge.

CHARLES WORTHINGTON,
Statistician.

HON. GEORGE B. LORING,
Commissioner.

REPORT OF THE ENTOMOLOGIST.

SIR: I have the honor to submit the following report of the investigations carried on by the Entomological Division of the Department of Agriculture during the past year. These researches have been briefly as follows:

The investigation of insects injurious to orange trees has been continued. As it was found early in that investigation that by far the greater part of the injury caused by insects to citrus fruits is due to scale insects (*Coccidae*), an especial study has been made of that family; and the inquiry has been broadened so as to include a study of all scale insects infesting cultivated plants, especially fruit trees, in the United States. Many of these are described in this report; but there is a far greater number in the collection which we have studied, but which I have been unable to describe for want of time.

A series of experiments to determine the most practicable way of destroying scale insects has been conducted. The results of the more important of these experiments are given in this report.

In the course of the investigation of scale insects, a study has been made of the parasites of the members of that family. Of these, thirty-one species have been bred, twenty-seven of which, all of the order of Hymenoptera, are new to science. As my assistant, Mr. L. O. Howard, is making a special study of the parasitic Hymenoptera, I referred these parasites to him, and he has prepared a paper in which they are described, and which I submit as a supplement to my report.

In addition to these special investigations, various insects of economic importance have been studied. Accounts of nearly fifty species of these are given in this report.

I have been assisted in my investigations throughout the year by Mr. L. O. Howard, Mr. Th. Pergande, and Mrs. Anna B. Comstock; and during a part of the time by Prof. C. H. Fernald and Prof. W. Trelease. Mr. Howard has aided in the preparation of the report and in the general work of the division; Mr. Pergande, in the care of the insects bred in my office, and in making biological notes upon them; Mrs. Comstock in the general work of the office and in the preparation of the report; Professor Fernald in the preparation of the report, and Professor Trelease in making experiments with remedies. The figures illustrating this report have been drawn from nature by Mr. George Marx and Mrs. Comstock.

Respectfully submitted 15th June, 1881.

J. HENRY COMSTOCK,
Entomologist.

HON. WILLIAM G. LEDUC,
Commissioner of Agriculture.

PART I.

MISCELLANEOUS INSECTS.

THE SUGAR-CANE BEETLE.

(*Ligyrus rugiceps* LeC.)

Order, COLEOPTERA; family, SCARABAEIDAE.

A stout black beetle 17 millimeters (0.6 inch) long, boring into the stalk of sugar-cane under the surface of the ground.

This, the most serious insect enemy of the sugar cane known in the United States, has created great anxiety in those localities in which it has become destructive. We, therefore, have made an effort to learn all that is possible respecting its life history, and the most practicable ways of preventing its injuries. Much, however, remains to be discovered; and this account is published for the purpose of placing before the sugar planters what is known respecting this pest, and to indicate the lines of investigation which it is important should still be followed.

It is hoped that those who have opportunities for making daily observations, and who are really the ones most interested in the matter, will help us to clear up the life history of the insect, and will aid us by conducting experiments in protecting their crops from its ravages. The department will do all in its power to accomplish these ends; but its efforts can be greatly facilitated by the co-operation of those planters whose fields are infected by the beetle.

The principal source of our present information respecting this insect, in addition to what has been learned through correspondence with planters, is the results of an investigation made during the month of March, 1881, by my assistant, Mr. L. O. Howard, who was sent to Louisiana by the department for the purpose of studying this and certain other important insects.

HISTORY.

The cane-beetle was first scientifically described by LeConte, in 1856, from specimens received from Georgia, and has since been known to collectors as rather a rare Southern insect. It has occasionally been known to economic entomologists as slightly damaging corn, and we believe that it has also been found to injure grasses (American Entomologist, III, 130). There can be no doubt but that it was known to planters in Saint Mary's Parish, Louisiana, as a sugar-cane enemy in years previous to the war, but we are unable to find that anything was published about it at the time. It seems to have been unnoticed for a long term of years, until in 1876 it again appeared about Franklin. The plantation owned by Mr. L. Swamsteadt was injured to some extent that year, and still more so the two following years. In 1879 the loss was slight, but the beetle was found over quite a large extent of country. In the spring of 1880, after a remarkably open winter, the beetle appeared in force. It damaged Mr. Swamsteadt's crop to the extent probably of a loss of 200,000 pounds of sugar. The crops upon the plantation of Messrs. Edouard Celon, D. Caffrey, Charles Walker, Daniel Thompson, and many others, within a range of fifteen miles or so of Franklin, were also damaged to a greater or less extent, but none of them so severely as that of Mr. Swam-

steadt. This gentleman calculates that his loss in three years from the beetle has reached $25,000. The beetle was mentioned in the last annual report of the department under the head of "Notes of the year."

DESCRIPTION OF THE BEETLE.

The largest specimens of the beetle will measure five-eighths of an inch in length, the smaller ones somewhat less. The color is jet black when fully matured, the individuals which have just metamorphosed being somewhat lighter. The head and fore part of the body (*thorax*) appear smooth, but with a hand-lens the head is seen to be roughly shagreened, while the thorax is covered with minute, round, impressed dots. The hind body (*abdomen*) is covered by the wing-cases (*elytra*), which have several longitudinal impressed lines, and also many impressed dots, such as are seen on the thorax. The front legs are broadened and the middle joint (*tibia*) is spread out fan-like and has four large tooth-like projections.

METHOD OF ATTACK.

The beetles make their appearance in early spring, and, as the experience of the present spring has proved, if the cane is not yet up and ready for them, they will bore into the stubble and may also work into the seed cane, where their injuries are greatly to be feared, as they will, preferably, without doubt, take the eyes to any other portion of the hard cane. Mr. F. Dumartrait found several of the beetles working in stubble upon Mr. Swamsteadt's plantation on March 17, this being their first noticed appearance in this season. In previous years, however, the presence of the beetles was first indicated by the withering of the top section—the bud leaves of the cane—after it was well up. These leaves finally died entirely, and with but slight effort the section could be pulled out. Such stalks, upon examination, showed the beetles in greater or less numbers below ground, burrowing to the center, in many cases being entirely concealed within the stalk, in others with only the head and thorax buried. So abundant were they last season that no less than 57 were counted in an 18-inch section of a row, and they often averaged 13 to a single stalk. In May and June they were observed flying very abundantly at night, and the testimony that they were greatly attracted by light seems to be irrefutable. They were reported to have left the cane entirely and to have disappeared in late June by many planters, but upon Mr. Swamsteadt's place they were found all through the summer, though the damage grew less as the cane grew larger and tougher. One specimen was found alive in seed cane as late as December.

In many fields where the beetles had not been remarkably numerous, after their disappearance in June the cane suckered so well as almost to repair the damage done by them. In others, however, all cane was completely killed, and in some cases it was plowed under in midsummer and the fields planted to corn. In such cases it is worthy of remark that the beetle destroyed the corn in the same way that it had the cane.

EARLY STAGES OF THE INSECT.

It was considered as among the probabilities that the earlier stages of the beetle (of which the first is undoubtedly a white grub living under ground upon living or decaying vegetation or in rotting wood) would be found at the roots of the cane, and our correspondents were

requested to search for them there. As an answer to this request came a number of pupae found about cane roots, from several gentlemen, but these upon being reared to the adult state proved to be an allied Scarabaeid beetle (*Phyllophaga glabripennis* LeC.), which has never been known to injure cane. Mr. Howard made a most thorough search for the earlier stages of the beetle. In the earth at the roots of the cane two species of Scarabaeid larvae, or "white grubs," were found, but that they were the larvae of the cane-beetle is very improbable, from the fact that the same two species were also found in Plaquemines Parish, where the beetle is unknown; and that they injure the roots of the cane to any extent is also negatived by the fact that they were also found as abundantly in the soil of the "headlands" or "turn-rows," and also in the lawn in front of the house, as well as in land grown to cow pease last season. It is probable that these larvae will be found to be the young of the beetle mentioned above, *Phyllophaga glabripennis*, and perhaps of *Lachnosterna fusca*, var. *puncticollis*, which was also found by Mr. Howard alive and hibernating in the earth among the stubble. The soil in every condition of cultivation in injured localities was carefully examined, with no results so far as Ligyrus was concerned, and we can say with considerable certainty that the insect in any stage of growth is not to be found in the fields during the winter. The most natural supposition after this conclusion is that the metamorphoses are undergone in the surrounding swamps, and that the adult beetles make their appearance in early spring and fly to the cane plantations.

But contrary to this conclusion is the following fact: On May 22 Mr. W. J. Thompson, of Calumet plantation, Bayou Teche, sent to the department, among other insects collected at the roots of cane where the beetles were very abundant, a few very young white grubs, of a species different from any sent by any other correspondent, and also differing from any which have been found since. These were placed in a breeding-cage under roots of grass. On August 2 one of the grubs was observed to have changed to a pupa in an oval cavity two or three inches below the grass roots, and on August 24 a crippled beetle was found in the cage, which, though badly deformed, seems without doubt to be a true cane-beetle. Of course this single instance needs confirmation, and we would earnestly request that during the months of June and July search should be made among the roots of cane, and that all white grubs found be forwarded to the department for rearing.

CHARACTER OF FIELDS MOST INJURED.

It was puzzling at first to account for the fact that the injuries of the beetles were confined to certain sections of fields, or to plantations the surroundings of which and the method of cultivation in which seemed identical with non-injured sections, but it was noticed that there was quite a marked difference in the character of the soil, that of the injured portions being more sandy and friable, while that of the other parts was of the common, heavy, clayey, alluvial soil—soil in which the experienced person on turning it over would at once reject the idea of finding insects. The former, found only upon the highest parts of the plantation, is soft and loose, easy to burrow in, and when examined is found teeming with insect life. Mr. Swamsteadt's plantation, the one worst damaged, is remarkable for this peculiarity of the soil; while all the testimony so far gathered upon this point seems to confirm the fact that Ligyrus works almost exclusively on cane grown in soil of this character.

One of our correspondents made mention of the fact that previous to 1880 rattoon cane had been principally damaged, while in that year both rattoon and plant were equally eaten. This fact it was which first suggested the idea that the beetles bred at the cane roots, and, hibernating in the stubble, naturally first appeared there and did most harm. The explanation of the fact probably is, however, that in ordinary seasons the beetle appears before the cane is up, and takes to stubble as the only food appearing. Last year, however, the cane being so very forward upon the appearance of the beetle, both stubble cane and plant cane were at his disposal.

REMEDIES.

Until the earlier stages of the beetle can be more fully studied than they have been, we shall have to confine our energies to destroying the adult insect. The first method of destroying it is suggested by the readiness with which it is attracted to light; the testimony that it is so attracted being very conclusive. Hence we shall advise the use of trap lanterns. It has been urged in many cases that the use of these lanterns attracts from surrounding plantations many more insects than are destroyed; but even supposing this to be true, it would only be necessary to secure unity of action among a few neighboring planters having the same interests, and the results would certainly far more than repay the expenditure. It is a very easy matter to experiment in this direction, and such experiment should be made. The success had with trap lanterns in Central Texas, in protecting the cotton crop from cotton-worms and boll-worms as mentioned in the Report on Cotton Insects, p. 263 (see also Annual Report for 1879, pp. 330–332) would seem to be a surety for their probable success here. The form of lantern in use there is very simple. The whole apparatus consists of three pieces: 1st, a shallow tin pan 15 by 10 inches; 2d, a common kerosene lamp with a half-inch wick and large enough to burn all night; 3d, a common lantern top large enough to place over the lamp and protect it from wind and rain. The lamp is placed in the middle of the pan and the latter filled with water, on which has been put a small quantity of coal oil. The whole thing is placed upon a post high enough to be above the top of the crop. The cost of a lamp is 50 cents, and the cost of burning it and labor about 35 cents a month. A great many patent lanterns have been devised, many of them very complicated, but the simple ones seem to work just as well. A simple closed tin receptacle for oil, with a wick tube and soldered to the bottom of a pan, the whole mounted on a stake which can be driven into the ground, is often used. It will not be necessary to figure any of the lanterns which have been patented, as any planter can devise one on the above principle which will meet all requirements. There is no doubt whatever but that the very best substance to put into the pan is water, with a tablespoonful or so of kerosene oil. If a beetle, in the course of its flight about the lamp, once falls into the oil on the surface of the water, its death is assured. The water is used simply to economize the oil.

Considerable has been said among the planters of the Teche region with regard to the use of lime as a protection against the cane-beetle. In fact we learn that this substance was placed by one planter around the roots of infested cane during the summer of 1880, with the apparent effect of driving the beetles away. But as they also disappeared about this time upon plantations where this substance had not been used, the experiment cannot rank as a conclusive one. Many planters have signified their intention of experimenting with this substance the

present season, and one sowed a quantity of lime with his seed cane as he planted it last fall, with the idea of keeping the beetles away, but it seems probable that its influence will have become dissipated by the time the beetles make their appearance. It will be best to postpone the planting of the infested portions of the field until spring, and then it is possible that the sowing of lime with the seed may prove of benefit. To experiment with lime upon stubble cane, it seems to us that it should be sown as soon as the cane begins to appear above ground.

THE SUGAR-CANE BORER.

(*Diatraea saccharalis* Fabr.)

Order, LEPIDOPTERA; family, PYRALIDAE.

Boring into the stalk of sugar cane and making a longitudinal burrow from 2 to 6 inches long, a white cylindrical larva, over an inch long when full grown, transforming within the burrow, and eventually becoming a light-brown moth, expanding about an inch and a quarter.

HISTORY.

For many years the sugar-cane borer has proved very destructive to cane in the West Indies. Several of the earlier writers upon cane culture mention its ravages, which appear to have been particularly marked in the Windward Islands, especially in Guadaloupe, in 1785 and 1786. The borer moth was first scientifically described by Fabricius, in 1793, as *Pyralis saccharalis* (Ent. Syst., III, ii, 338), and was afterwards redescribed by Rev. Lansdown Guilding, a resident of Saint Vincent, Windward Isles, as *Diatraea sacchari*, in an essay upon the habits of the borer, for which he was awarded the Ceres gold medal of the London Society of Arts (Trans. Soc. Arts, XLVI, 143). About 1850 the borer appeared in Mauritius, and was the occasion for an article upon its habits by Westwood, in the Gardener's Chronicle (1856, p. 453).

Of late years we have heard of serious damage by what is in all probability the same insect in British Guiana. Miss Ormerod, of the London Entomological Society, has written two papers upon this and the Coleopterous borer, *Calandra palmarum* (see Proc. Lond. Ent. Soc., 1879). She makes reference to reports upon the borer by Mr. Im-Thurm, curator of the British Guiana Museum, Georgetown, but which we have not yet seen.

We are indebted to Professor Fernald for the information that in a paper just published Zeller adopts the genus *Diatraea* and describes several species from South America, but states that Fabricius's description of *saccharalis* is so general that it will apply to several of them. He therefore drops Fabricius's name altogether. In the absence, however, of a more correct specific determination we prefer to hold to the old name.

In the United States the borer appears to have attracted but little attention, and we cannot find that any articles have been published upon it. That it has existed in Louisiana, however, for many years is beyond doubt. Dr. J. B. Wilkinson, of Plaquemines Parish, states that in 1857 the borers were very abundant along the Lower Mississippi, the crop upon one plantation being utterly destroyed, as the canes broke to pieces without cutting. He also informs me that one of the earlier writers upon the West Indies has recorded the observation that they were abundant only upon plantations near the sea-coast, and says that he has noticed the same thing in our country.

The borer was first received at the department in 1878, from W. W. Pugh, of Assumption, who evidently considered it a rarity, and in October, 1880, a second specimen was received from the same gentleman. In February, 1881, a single worm taken from seed cane was forwarded by Dr. Wilkinson, with the statement that it had considerably damaged his crop in the previous year. From the observations of Mr. Howard during his trip in March, and from information gathered from other sources, we may state the following concerning the habits and life history of the borer.

HABITS AND LIFE HISTORY.

In early spring the parent moth lays her eggs upon the leaves of the young cane, near the axils, and the young borer hatching in the course of a few days, penetrates the stalk at or near the joint, and commences to tunnel upwards (invariably?) through the soft pith. The eggs, which, however, we have only seen upon corn, are flat and circular, 1^{mm} (one-twenty-fifth inch) in diameter, and are white when first deposited, turning yellow as they approach the hatching point. The growth of the "borer-worm" must be very rapid.

The very closely allied, if not identical, corn-stalk borer which is treated in the next article, under the disadvantage of dry food and cool temperature occupied but 30 days in the larva state, and in midsummer in the South the growth will probably be much more rapid. The borers are quite active, and occasionally leave their burrows and crawl about upon the outside of the stalk, seeking another place to enter. This accounts for the numerous holes, differing widely in size, to be seen upon the outside of a badly-infested stalk. The full-grown borer is about an inch long, rather slender, nearly cylindrical, and cream white in color, with a yellow head and black mouth parts.

We have, however, only seen the hibernating larvae, and it will perhaps be found that the summer borers are furnished with black spots. Upon attaining its full size it bores to the outside of the cane and makes a large round hole for its future exit—a hole which is usually at least 5^{mm} (one-fifth of an inch) in diameter. It then retires into its burrow and transforms a short distance from the opening into a slender brown pupa, three-quarters of an inch long. The pupa state lasts but a few days, and then the moth makes its exit. The moth has a spread of wings of about an inch and a quarter, and is of a light grayish brown color. With the female moth the hind wings are of nearly the same color with the fore wings, but with the male the former are silvery white.

It is impossible to estimate, at present, the number of broods, but there are several in the course of the season. Where the insects have been abundant, towards the end of the season the canes present a sadly damaged appearance; in some of them every section has had two or three of the borers at work, rendering them, of course, worse than useless. It is to be observed also that even in canes in which but one or two of the borers have operated, the other joints are very apt to become diseased, and seed cane which has been tunneled by the worms naturally mildews and decays much more readily than the sound cane.

AMOUNT OF DAMAGE.

Last year (1880) the cane-borers were very abundant in various parts of Plaquemines Parish, and we also heard of their presence in Assumption and Saint Mary's Parish. On questioning several planters in the latter parish, it was learned that the borer has been known there for

years, but has never been sufficiently abundant to attract especial attention, and most of the planters knew it only by its holes in the cane. The very early spring of 1880 and the open winter which preceded it, while forwarding the crop, were also favorable to the hibernation and rapid development of the worms. Upon Dr. Wilkinson's plantation (near Wood Park, parish of Plaquemines), fully 10 per cent. of the canes were injured, and in some places, where the damage was greatest, as high as 30 per cent. The crops upon other plantations in that vicinity were also injured as much. The loss would have been felt quite severely had it not been such an extremely favorable cane year.

REMEDIES.

According to our present information, the cane-borers hibernate almost exclusively in the larva or "worm" state. During the winter they are to be found most abundantly, of course, in the seed cane, but also in the discarded tops, and also to a slighter extent in the stubble. We cannot hope, of course, to exterminate the insect, owing to the extreme difficulty of fighting it in the stubble, but the number of larvae which hibernate in this place is so small that, supposing the others killed off, the borer can be well kept in subjection. It is the custom upon most plantations to plow the tops under for fertilizers, but if the plan of burning them during the winter were universally adopted, many of the borers would doubtless be killed which otherwise would help to start the next summer's brood.

The question of dealing with by far the larger number, which are to be found in the cane stored away for seed, now remains. In such cane as is planted in the fall it is reasonable to suppose that the borer will not be able to develop, or if it should develop that the moth will not be able to force its way through the wet heavy soil above it, especially where the system of rolling after planting is followed. Why should not the same reasoning apply to such seed cane as is laid down in furrows at the time of harvesting? It would depend, of course, upon the amount of earth with which it could be covered without danger from mildew and decay. After a bad worm year all seed cane should be laid down in this way and not left openly in flat "mat," which allows of a safe hibernation and an easy natural escape of the moth. The cane should be covered as deeply as is safe in order to more effectually stop the egress of the moth, and in planting the ensuing spring only so much should be uncovered at a time as is necessary for immediate use. In harvesting in the fall also such canes as are worst infested should be thrown aside with the tops, to be burned during the winter. Moreover, inasmuch as certain parts of a plantation are always damaged more severely than others,* the seed to be kept through the winter should be selected from other localities and from amongst the very best and least damaged cane. We cannot insist too strongly upon the necessity of following this latter course. If these suggestions are acted upon, we think that the damage from the borer will be very greatly lessened.

NOTE.—We are anxious to get the materials for a very complete life history of the cane-borer, and would therefore solicit specimens at all times of the season. To any one signifying his willingness to send us specimens we will gladly send the requisite mailing boxes and stamps.

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* Such parts are the lower portions, where the cane gets an earlier start, and also next the draining ditches, where the moths find an excellent harboring place during the day amongst the rank vegetation.

THE CORNSTALK-BORER.

Diatraea saccharalis (?) (Fabr.)

Order LEPIDOPTERA; family PYRALIDAE.

Boring into the stalks of corn near the ground, a white larva, most often with dark spots, measuring when full grown about one inch in length; transforming to a slender brown pupa within the stalk, which eventually gives forth a light-brown moth. with a wing expanse of an inch and a quarter.

Early in July an account was received from Dr. W. L. Anderson, of Ninety-Six P. O., Abbeville County, South Carolina, of the injury done to corn in his vicinity by a lepidopterous stalk-borer, and the moths which he had reared and which accompanied the letter sufficed to show that it was probably an insect new to economic entomology. A continuous correspondence with Dr. Anderson through the summer, fall, and winter, and also with Prof. J. E. Willet, of Macon, Ga., through whom specimens of the same insect were received from Mr. W. L. Hawes, of Leathersville, Lincoln County, Georgia, and an extensive rearing of the insect in the breeding cages at the department have put us in possession of the following facts concerning this new pest. That it is a *new* injurious insect, however, only in the sense that nothing has been published about it before, is shown by the fact that it is figured upon one of Professor Glover's unpublished plates as "injuring maize in South Carolina."

The eggs of the borer moth we know only from specimens deposited upon the bottom of a box by a moth in confinement. They are very flat, almost circular, nearly 1^{mm} (.04 inch) in diameter, and were fastened to one another and to the bottom of the box so tightly that it was impossible to separate them without crushing. Their color was milk white with a faint greenish tinge when first deposited, but became orange yellow with a transparent center later. Seen with a microscope the whole surface is coarsely facetted. In a state of nature the eggs are in all probability deposited on the leaves near their bases in small groups. Under the unnatural conditions above mentioned they hatched in six days from the time of being layed.

The newly hatched borer is about 2^{mm} long, broad at the head and tapering towards the end. The color is orange yellow, but each segment bears a row of reddish warts which give the whole larva a reddish appearance. The head is black, polished, and very flat, and is of a very convenient shape for an entering wedge in forcing its way between leaf and stalk. The young larva is very active, crawls about rapidly, and frequently drops, suspended by a silken thread, from one leaf to another. Dr. Anderson noticed that on stalks infested by these larvae the leaves were full of holes, presenting the appearance of the work of the boll worm on corn as described in the Annual Report for 1879, p. 340. He says: "After diligent search I cannot find one of the stalks that is riddled in the blade that is not perforated in the joints near the ground, and *vice versa*." The natural supposition is that the riddling is done by the young borer before entering the stalk, although the possibility still remains that it might have been done by the "bud worm" or "tassel worm," as the boll worm is called when it works in corn.

The larva soon works its way down the leaf to where it is sheathed around the stalk and enters the latter, commencing a cylindrical burrow.

It grows rapidly and sheds its skin four times before reaching its full growth, which in the breeding cages at Washington took 37 days for the midsummer brood; but undoubtedly in the field, with fresh food and warmer atmosphere, they would develop more rapidly. In the course of its growth the borer not infrequently comes to the surface and leaves the stalk, entering it again at some other point, which will account for the numerous holes occasionally to be seen in the stalk. When full grown it measures nearly, if not quite, an inch in length. It is nearly cylindrical, tapering slightly towards either end, and is furnished upon its back with many brown or blackish spots, six upon each segment, arranged in two transverse rows, four in the front row and two in the hind, the hind two slightly wider apart than the middle two of the front row. Each segment has also a spot on each side (lateral) and two below (subventral). In the late fall brood—the hibernating larvae—these spots become obsolete, and they resemble very perfectly the borers found in sugar cane. The burrows are almost invariably near the ground, in the first or second joint, rarely more than a foot from the surface.

The pupa state is entered upon within the stalk, the larva making an opening for the egress of the moth before transforming. The pupa is rather slender, three-quarters of an inch long, dark brown in color, and very rough upon the back when viewed with a lens. The duration of the pupa state in summer is probably not more than six or eight days.

The moth is of an ashy gray color and has a wing expanse of about an inch and a quarter. With the female, the hind wings are of nearly the same color as the fore, while with the male the former are silvery white. When at rest the wings are folded close to the body, and the moth is a very inconspicuous object.

As to the number of generations in a season, we have every reason to suppose that there are three; possibly more. The moths from the first brood were sent to the department the first week in July. Two weeks or more later a moth of this brood laid eggs which hatched in a week, and the larvae from which reached their full growth in the third week in August, the moths appearing about the first of September, and their offspring living in the stalks through the fall and winter. There is great irregularity in the broods, however, as is shown by the fact that Professor Willett bred moths the first week in August, which were, without much doubt, of the second brood.

That the borers customarily hibernate in the larva state within the stalks there can be no doubt. Specimens were received from Dr. Anderson November 1 with the remark that he found one or more alive in the first four stalks examined, but noticed that they had a "sickly look." This, however, was probably due to the pale color which the hibernating individuals take on. March 1 more full-grown worms were sent, with the information that he had not been able to find a chrysalis in the stalks, but several worms. Moreover, all of the larvae which were being reared in the department hibernated without change.

As to the extent of the injuries of the borers, Dr. Anderson says that he has heard rumors of great damage, but has seen none worse than upon his own farm, where not more than 5 per cent. of the stalks were badly damaged. More than 10 per cent., however, contained the borer, as high as ten having been found in one stalk, although commonly not more than three or four were present. The perforated stalks not infrequently held good ears, but a slight wind would suffice to break them down. Mr. Hawes gives a higher estimate of its damages in his locality. He says that he has heard of its destructiveness over a good portion of East and Southeast Georgia. A great deal of the corn affected falls

down, amounting to at least 10 per cent. of the crop, and that which remains standing never yields much; so he estimates the damage at about 25 per cent. Mr. Hawes also noticed that upland corn and corn planted very early or very late seem to be more liable to injury, while that planted intermediately or upon lowlands escaped. Dr. Anderson noticed that late bottom-land corn escaped.

A most satisfactory remedy for the injuries of the corn-borer can probably be derived from the fact that it hibernates in the larval state in stalks and stubble. The stalks should be put out to fodder early, and the remains not eaten burnt before February. The stubble should preferably be plowed up and burned, or plowed under very deeply. The latter course will perhaps be sufficient to prevent the exit of the moths, and will save the trouble of collecting and burning; but it must be very thoroughly done.

As to the identity of the insect with the sugar-cane borer (*Diatraea saccharalis*) we cannot speak positively, but the evidence so far collected seems to point to such identity. The methods of work are exactly similar. It is impossible to distinguish the hibernating larvae taken from cornstalks from those taken from cane. The summer larvae of the latter we have not seen, and herein may lie a difference. The pupae seem to be indistinguishable. The only moth which we have bred of the cane-borer is a male, and while varying considerably from the corn stalk males, still seems to remain within specific limits. The species seems to be quite a variable one, judging from the specimens bred. The principal difference to be noticed between our one male of the cane-borer and the males of the cornstalk-borer is in the greater breadth of the wings in the latter. Specimens of the cornstalk moths were referred to Professor Fernald, who pronounced it to have been undescribed by American authors, and he kindly forwarded them to Professor Zeller, who replied: "The Crambid is a *Diatraea* near *obliteratella* [Zell.], but unknown to me." In the present state of uncertainty we prefer to leave the species as *saccharalis*, with an interrogation.

THE CORN LEAF MINER.

Diastata? ——— n. sp.

Order DIPTERA; family GEOMYZIDÆ.

Mining the leaves of garden corn, making a linear mine 5 or 6 inches in length, a small, footless, greenish-white maggot, which transforms under ground, and eventually becomes a small active black fly.

In the latter part of June, 1879, the leaves of garden corn in South Washington were discovered to be mined by some insect. These mines were narrow, measuring at their widest point from 2^{mm} to 3^{mm} (0.1 inch), but frequently attained a length of from 130^{mm} to 150^{mm} (5 to 6 inches). They were usually to be found near the edge of the leaf, which they caused to curl slightly. The mines were visible from both surfaces of the leaf, although they were more perceptible on the upper surface, being lighter colored above than below. They were quite abundant, three or four frequently occurring on the same leaf, and the whole patch had a sickly appearance. Examining the mines more closely, many black specks were to be seen from the upper surface, which were evidently the excremental pellets of the inclosed larva. Upon removing the upper surface of the leaf, the inhabitant of the mine was found to bear a striking resemblance to the clover leaf mining *Oscinis*, described

in the last annual report (p. 200), with the exception that it was more than twice as large. Its length was 4.5mm (0.17 inch). It was rather slender, its back was somewhat arched, and the downward bent prothoracic tubercles gave the same piggish look to the head and first segment as was noticed in the clover miner.

About the 12th of July the larvae began to force their way through the upper skin of the leaf covering the mine and dropped to the ground, where they burrowed just under the surface, and transformed within oval, brown puparia. Three weeks afterwards the first and only fly made its appearance. It was 3.5mm (0.13 inch) long, rather slender, shining black in color. Among a small collection of Diptera sent to Mr. Edward Burgess for determination this was returned labeled "*Diastata?*"

During the season of 1880 these leaf miners were extremely difficult to find, which was doubtless owing to the very extensive parasitization of the 1879 individuals. Out of thirty or forty specimens examined but one contained a sound larva, which was reared to maturity, all the rest containing several minute parasitic larvae. These larvae as they increased in size completely filled the interior of their host, transformed within them, and issued as chalcidian flies shortly before the time when the dipterous larva would have transformed had it been left to itself. From four to eight of the parasites issued from each mine, each fly making a round hole of exit for itself through the upper epidermis. This parasite proved to be a new species of the genus *Entedon* Dalm. I referred it to Mr. Howard, who has submitted the following diagnosis:

ENTEDON DIASTATAE, Howard (new species).

Length of body, ♂, 0.8mm; ♀, 1.1mm. Expanse of wings, ♂, 1.6mm; ♀, 1.8mm. Width of fore wing, ♂, 0.32mm; ♀, 0.46mm. Antennae, short; scape, $\frac{3}{4}$ths the length of the flagellum; joints 2, 3, 4, 5, and 6 subequal, rather stout, increasing slightly in size; joint 7, much smaller than the others, acuminate at tip. Head, thorax, and abdomen of same width. Color: head, steel blue; eyes, brown; antennae, brown, with whitish pile, scape black; thorax, metallic green; abdomen, black; legs, yellowish white, except femora, which have their middles bluish black. Top of head and upper surface of thorax coarsely impressed; abdomen, smooth.

Described from many ♂ and ♀ specimens.

THE HOG CATERPILLAR OF THE ORANGE.

Papilio cresphontes Fabr.

Order LEPIDOPTERA; family PAPILIONIDAE.

Feeding upon the leaves of orange throughout the summer, a large, thick, gray caterpillar, with two large, irregular, cream-colored spots upon its back; transforming to a very large black and yellow butterfly.

In speaking of the caterpillar of this butterfly in his report on orange insects (Patent Office Report, Agriculture, 1858, 265), Mr. Glover stated that it was very injurious to the foliage of the orange. Boisduval and Le Conte (Histoire des Lépidopteres et des Chenilles de l'Amérique Septentrionale 1833) say concerning this caterpillar that it lives upon all the trees of the genus *Citrus*, and is in some parts of America in a measure a scourge to the orange growers. I, myself, found several of the chrysalides upon orange trees in my recent visit to Florida, and since my return specimens of the caterpillers have been sent to the department by Mr. G. W. Means, of Micopany, Fla.; Mr. H. S. Williams, Rock Ledge, Fla.; and Mrs. Rebecca A. Minor, of Houma, La.,

all reporting them as doing more or less damage to orange foliage. Mr. A. T. Harvey, of Lake Griffin P. O., Sumter County, Florida, informs me that he has had many orange seedlings completely defoliated by these larvae—"orange dogs" as they call them in that part of the country.

The eggs from which these larvae hatch are deposited singly upon the leaves, are sub-globular in form, somewhat flattened on the side of attachment, and yellowish white in color after hatching. What their color is before hatching we are unable to say, as the only specimen received at the department hatched on the journey. They were sent by Dr. Turner from Fort George, Fla. In confinement the larvae occupied thirty days in attaining their full growth, and remained two weeks in the chrysalis state before giving forth the butterfly.

The young caterpillars are almost precisely like the full-grown ones in form and color, except that the gray markings are darker and the white blotches not so extensive as at a later stage of growth.

The full-grown larva is something over two inches and a half in length, and is very peculiarly marked. The belly and legs are brownish; the first four segments have upon each side a longitudinal white band; between these two bands above, the body is brownish, with large spots of a darker color; upon the middle segments, beginning with the fourth and ending with the eighth, there is a large white space shaped like a lozenge, one of its corners reaching to the first pair of prolegs on each side; several brownish dots are to be seen upon this band; another similar white or cream-colored blotch covers the posterior part of the body; this blotch also contains some brownish dots; the sides of the body between these white spots are of a uniform dull brown. One of the most striking points connected with these larvae is one which they hold in common with other members of the genus, namely, the possession of two long red fleshy filaments or "tentacles" upon the first thoracic segment, and the power to withdraw or extrude them at will. Upon being disturbed the larva always protrudes these organs, which, by the way, have a very disagreeable odor, and directs them towards the place of disturbance. It is considered that these organs are a protection to the caterpillars against the attacks of ichneumon flies and other parasitic and predaceous insects.

The chrysalis of this insect affords one of the most marked instances of protective resemblance which it has ever been our good fortune to see. It is nearly an inch and a half in length, is irregularly forked at its upper end, has a prominent point upon its breast, and is suspended by a loop of silk around its middle, its tail being also fastened to the supporting twig or leaf. Its color (I have only examined the hibernating chrysalides) is of varying shades of gray and brownish, so exactly of the color of the orange bark that it is extremely difficult to see it. The irregular projections of the head and breast, and sundry makings resembling cracks in the bark, and even minute lichens growing upon it, bears out the striking likeness to a bit of a knotty orange branch most perfectly. It is worthy of remark that Mr. Glover states that the chrysalis is greenish in color, but this discrepancy may be explained by the probability that he was describing the chrysalis of one of the summer broods, or one which had just transformed.

The adult insect is one of the handsomest of the southern butterflies. Its spread of wing is from 4 to 5 inches. The ground color above is black, and an irregular triangle of broad yellow spots includes a large part of the wings. The under side of the wings is yellowish with black nervures and a row of crescent shaped blue spots on the secondaries.

There are usually four broods of the butterflies in the course of a season, the last brood wintering in the chrysalis state, and the adults making their appearance the ensuing April.

From what we have been able to learn, these caterpillars have not been abundant enough of late years to do much damage, yet from the statements of Boisduval and Le Conte and of Glover, referred to before, they have undoubtedly been so in years past. This being the case, the obstacle to free development which has kept them in check is liable at any time to be removed, and we may have them abundantly any year.

That the scent organs have not succeeded in making them free from the attacks of parasitic insects is shown by the fact that from chrysalides collected at Jacksonville, Fla., in January were bred several specimens of a Tachina fly. It is possible, however, that the eggs of the parasite were deposited after the caterpillar had transformed to chrysalis.

As to remedies, it will not be difficult to keep these insects in check by hand-picking, as they are easily seen on account of their size. The butterflies being so conspicuous can without much trouble be caught in hand nets.*

THE ORANGE APHIS.

Siphonophora citrifolii Ashmead.

Order HEMIPTERA; family APHIDIDAE.

Puncturing the leaves and buds of orange, principally in spring; numerous minute plant-lice.

Strange as it may seem, although it has been known for many years, the common aphis of the orange was never scientifically described until the appearance of Mr. Ashmead's book on orange culture this year.

Like the cotton and the grain aphis, it is only the early broods which do much damage, the foliage being tenderer at that season of the year, and the lice themselves being comparatively free from the attacks of their parasites and other enemies. Upon the orange it is only the new shoots and tender buds which are injured by the attacks of these lice. They are about five hundredths of an inch in length and are green in color, shaded with dark brown upon the back and sides. The antennae are as long as the body, and the honey tubes are prominent. There are winged broods in April and in August, and probably other times, although these are the only periods when we have actually observed them. If it were not for the parasitic and predaceous insects which hold them in check, the effects of their work would soon prove disastrous. The young growth would be entirely killed off.

During the summer many specimens of these lice have been sent to the department from different sections of the orange-growing States, and almost without exception every individual received was parasitized by a little ichneumonid which may be known as the "red-legged Trioxys" (*Trioxys testaceipes* Cresson, see Dept. of Agr. Ann. Report, 1879). This parasite is about the size of the aphis, and is shining black in color with yellowish red legs. The same insect also infests the cotton plant-louse (*Aphis gossypii*) and the grain louse (*Aphis avenae*.)

The lady-birds, aphis lions, syrphus flies are all of course destructive to

*Of other insects belonging to this genus which feed upon orange, Boisd. & Le C. mention *P. epius* in the East Indies, *P. demoleus* in Western Africa, *P. lysithous* in Brazil, and state that there are several others which they could cite.

these aphides. The larvae of *Scymnus caudalis*, Le C., were found destroying lice sent from Rock Ledge, Fla. On many occasions the larvae and pupae of the twice-stabbed lady-bird (*Chilocorus bivulnerus*) were found upon the orange twigs, or upon the Florida moss upon the branches. This insect has been considered as injurious by several of our correspondents, one gentleman considering it the cause of the "die-back" for the simple fact that he could find no other insect upon the trees. Further examination, however, showed bark lice on the leaves, and on these the lady-birds have without doubt been feeding.

A rather peculiar looking syrphus fly has also been bred from larvae found feeding upon the orange aphides. This same insect has been noticed by Mr. Glover (see Rept. 1858, p. 262). Mr. Ashmead has also bred a chalcid from the orange aphis, which he calls *Stenomesius aphidicola*.

THE ANGULAR-WINGED KATYDID.

Microcentrum retinervis Burm.

Order ORTHOPTERA; family LOCUSTIDAE.

Eating the foilage of the orange tree: large green katydids.

In spite of the fact that at the North the katydids are generally considered as comparatively innoxious creatures, there is, perhaps, no insect of large size which is so destructive to the foliage of the orange as the one above mentioned. This insect was hurriedly treated of by Mr. Glover in the department report for 1858, and later its entire history was studied by Professor Riley (see sixth Missouri Report). The latter, however, did not consider it as an injurious insect, and merely detailed its life history from a naturalist's point of view.

During my stay in Florida, in the spring of 1880, I found the eggs to be very abundant, both upon the leaves of orange and upon the twigs of oak and other trees. Many eggs were forwarded to the department, and by means of the individuals hatched from these eggs the history of the insect studied.

The eggs were found to be laid in two ways. The first, as detailed by Riley, in a double row down a twig which had previously been chewed with the jaws and otherwise prepared for a place of deposit. The eggs of each row were laid alternately, and those in the same row were deposited in such a manner that they overlapped, the first egg having been placed in a sloping position, and the end of the second forced down under the raised end of the first. Upon twigs this was always found to be the arrangement, but upon leaves it was different. In the first place, there was but one row. This row was laid along the edge of the leaf, each egg obliquing towards the tip of the leaf, with its anterior end projecting beyond the edge, and its posterior border slightly overlapped by the preceding egg. The edge of the leaf was in no way roughened for the reception of the eggs, which were usually deposited upon the under surface. The shape of the eggs was a long oval, somewhat straighter upon one long edge than the other, and nearly flat, thickening somewhat as the hatching time approached.

With the leaf-laid eggs the young katydid, in every case, issued from the end of the egg which projected beyond the edge of the leaf, and the empty eggs from their split edges were readily distinguishable from the sound ones, the difference appearing similar to that between a closed

oyster shell and one partially open. The split is not confined to the external end, but also extends down the outside edge; which, by the way, is always the straight edge. With the double rows of eggs upon twigs the straight edges of the two rows approximate, and it was from the upper end and inner border that the larva made its exit.

From eggs collected in Florida in February the katydids commenced to hatch, and almost immediately began to eat, feeding at first only upon the surface of the leaves. In about nineteen days they shed their first skins and ate them up before proceeding with their leaf diet. There were three molts in addition to this first one, the third giving them large wing pads, and the fourth making them perfect winged insects. The cast-off skins were eaten after each molt, and in one instance one of the katydids was killed and partly devoured by his companions while yet in the soft and helpless condition succeeding a molt. Ninety-two days were spent in growth, which is undoubtedly much longer than would be occupied in Florida. The quantity of leaves eaten by these creatures during their active period of growth was something enormous, and afforded a good index to the amount of damage which must be done where they occur in any number. The copulation, taking place probably at night, was not observed. The first eggs were deposited twenty-five days after the first individual became winged, and from that time on through the summer many were laid along the edges of leaves and of strips of paper in the breeding cage. In many cases hunger drove the adults to the point of eating the leaves upon which eggs were deposited, but that portion directly supporting the eggs was not touched. In no case was there an attempt to lay the eggs upon twigs, from which we deduce the probability that they prefer to oviposit upon leaves, and do so except the in case of the last brood upon deciduous trees.

Young katydids of the second brood began to hatch during the month of August. The different individuals of the first brood had varied to such an extent in rapidity of growth that the eggs were necessarily deposited at times considerably separated. This, of course, had a marked influence upon the second brood, so that individuals of widely differing sizes were to be found during late summer. In the more northern States there is but one brood in a season.

Fortunately for orange growers there is a chalcid parasitic upon the egg of this insect, which seems to be quite common in Florida at least. It may be known as the *katydid egg parasite*, as no other has been found, and as it is not known to infest other insects. The adult insect is a curious looking individual, about .13 to .14 of an inch in length, with dusky wings and with an abdomen which it can elevate over its thorax in a strange way. On account of this and other peculiarities Walsh erected a new genus for the species which he called *Antigaster mirabilis*. Recently, however, Mr. Howard has shown (Canadian Entomologist, September, 1880) that in no respect does *Antigaster* differ from the old European genus *Eupelmus* of Dalman, and that the species should be designated as *Eupelmus mirabilis* (Walsh). The eggs of this parasite are deposited within the eggs of the katydid, and its larvae hatch and undergo their transformations within the eggs of the latter, issuing at last as adult flies through circular holes which they cut through the shell. There is never more than one adult parasite to issue from each egg, for although more than one parasitic egg may have been originally deposited in the egg of the host, only one arrives at maturity. As to the actual amount of good done by this chalcid, we give here the percentage of parasitized eggs in a few rows taken by chance. In considering this, however, it must be remembered that in many cases the parasite will

have died within the egg, and, although it has destroyed the embryo, does not pierce the shell to show it.

	Apparently unparasitized.	Parasitized.	Total.
1	1	13	14
2	11	4	15
3	2	18	20
4	13	10	23
5	12	12	24
6	22	9	31
7	25	5	30
Totals	86	71	157

To prove this the 86 apparently unparasitized eggs in the table were again examined, and 42 were found unhatched and unpierced. Upon opening these 22 were found to have died from some unknown cause, while the other 20 contained parasites. Of these parasites 4 were adults, all ready to issue, but unable to pierce the egg, 2 ♂ and 2 ♀; 13 were pupae, 3 ♂ and 10 ♀, while the other 3 were yet larvae. In one egg two pupae were found, one male and the other female, so that there may be an occasional exception to the rule laid down just before, that but a single parasite issues from an egg. This, then, would alter our totals to 66 unparasitized eggs to 91 parasitized, a change of from 44 to 58 per cent.

No better remedy for the injuries of this insect occurs to us than the collecting of the large and conspicuous eggs during winter. When collected, however, they should not be destroyed, but placed in a box covered with a wire gauze until spring in order to allow the parasites to escape.

THE ORANGE BASKET-WORM.

Platoeceticus Gloverii Packard.

Order LEPIDOPTERA; family BOMBYCIDAE.

Feeding upon the foliage of orange a small brown basket-worm, with an oblong oval case about 14mm long. The female moth, wingless; the male, small, delicate, brownish in color, with a wing expanse of 16mm (0.6 inch).

Years ago Mr. Glover gave a short popular account of this insect (Dept. of Agri. Rept. 1858, p. 264), and afterwards figured it in all stages upon one of his unpublished plates under the name of *Psyche confederata* Gr. and Rob.

Mr. Packard, in his Guide to the Study of Insects, p. 219, having seen Mr. Glover's drawings, gives it the name *Platoeceticus Gloverii*.

During the month of February I found many of the cases of this insect upon the orange in different parts of Florida, and at Rock Ledge, Orange County, it was also found upon guava.

The full grown larva is from 10mm to 12mm long, thick and fleshy in appearance, and varies in color from a light brown to quite a dark shade. The head and first segment are much smaller than the immediately succeeding ones, and the head is marked with wavy dark and light lines. The male case and the female case differ in size at full growth, that of the female being about 18mm long, while that of the male is but 14mm.

The adult male is a delicate small-bodied moth with feathery antennae. Its wings expand 16mm (0.6 inch), and are of a dusky color. The pupa

before giving forth the moth works its way out of the end of the case opposite to its attachment until only the last few segments of its body remain inside, and in this position the empty skin remains. All of the cases collected in Florida proved to be males, and consequently we quote Mr. Glover's statement that "the female never acquires wings, but when ready to change fastens the case to the leaf with silk, lays its eggs, and dies. The eggs are likewise laid in this case, and the young, when hatched, escape from the orifice at the lower end and disperse over the tree in search of food." This statement is certainly indefinite, but the state of the case is probably as with the ordinary bag-worm of the more Northern States (*Thyridopteryx ephemeraeformis*), with which the female never leaves the case, copulation being accomplished by means of the very long external penis of the male, and the eggs being deposited in the posterior end of the pupa skin.

Although this orange bag worm is not at present much of a pest, still it is liable to increase suddenly in numbers any year, just as the Northern Thyridopteryx has done the present year around New York City. There will be no good way of destroying them except by hand-picking, which fortunately the conspicuous bags will render easy. These bags and the eggs of the katydid could all be collected in the same journey through the orange grove.

We have found no natural enemies to this insect, although Mr. Glover records the fact that he found a "parasitical grub or maggot in one of these cases."

ARTACE PUNCTISTRIGA Doubl.

Order LEPIDOPTERA; family BOMBYCIDAE.

There is occasionally to be found upon the orange a fusiform white silken cocoon, an inch and a half in length. From this cocoon there issues in spring a thick-bodied woolly white moth, the female measuring an inch and three-quarters, and the male an inch and one-quarter across the wings. Each fore wing has five transverse rows of small black dots. We have not seen the caterpillar which spins this cocoon, but from an examination of the cast-off skin to be found at the end of the pupa, and from other facts, we may readily state it to be a rather thick larva, about an inch and a half in length, and covered with long mixed black and whitish hairs, giving it a grayish effect. These cocoons are not confined to orange, but are also found upon the grass at the foot of the tree, and one specimen received was evidently found upon cherry, as pieces of the bark still adhered. The species seems to be comparatively rare, but, as we have said before of other species, it is liable at any time to increase and become injurious; therefore the sooner it is treated of the better. As one of the causes of its rarity we may mention the existence of a large ichneumonid parasite, which we have not been able to breed, owing to the fact that it in its turn is parasitized by a chalcid, of which we have bred thirty-six specimens from a single cocoon, all having made their exit, as usual, from a single hole. It is possible that this chalcid may also be a primary parasite. The specimens were referred to Mr. Howard for study, and decided to be a new species of the genus Encyrtus of Dalman. Mr. Howard's description is appended.

ENCYRTUS ARTACEAE Howard, new species.

Female.—Length of body, 1.7^{mm}. Wing expanse, 3.4^{mm}. Width of fore wing, 0.6^{mm}. Antennae as long as thorax; second joint one-fourth as long as flagellum; third less

than one-half as long as second; fourth, fifth, sixth, seventh, and eighth increasing in diameter, but of nearly the same length as third; club large, nearly as long as joints 2 to 8, inclusive. Head, thorax, and abdomen subequal in width. Thorax flattened above, abdomen flattened, subcordate in shape. Head very slightly and sparsely punctured; so with the scutum; scutellum somewhat shagreened; abdomen smooth. Stigma given off before the middle of the wing, the marginal vein being very short. Spur of the middle tibiae slightly longer than first tarsal joint. Color: head dull bluish green, purplish towards mouth; mesothoracic scutum dull bluish-green; scutellum bronze colored; abdomen dark, with metallic tints; antennae dark brown, scape yellowish at tip, joint 3 yellowish; all legs with black femora, yellowish at tip, proximal half of tibiae black, distal half yellowish brown; tarsi light, with blackish claws.

Male.—Similar in all respects to the female, except that the thorax is somewhat gibbous.

Described from 36 ♂ and ♀ specimens, reared from an ichneumonized cocoon of *Artace punctistriga*, Doubl., collected at Fort George, Fla., by Dr. R. S. Turner.

THE CORK-COLORED ORANGE TORTRICID.

(*Tortrix rostrana*, Walk.)

Order LEPIDOPTERA; family TORTRICIDÆ.

Rolling up the edges of the leaves of orange and feeding on them, a small, greenish-yellow larva which transforms into a brownish pupa, and from which emerges a small, pale, cork-colored moth.

The larva of a leaf-rolling Tortricid on orange was received at the department from Dr. Turner, Fort George, Fla., January 31, and others were collected by myself at Lake Bearsford and Enterprise, Fla., in February, and still others were received from Dr. Turner as late as May 17. From these were obtained moths which were referred to Prof. C. H. Fernald for identification, and he sent them to Lord Walsingham for comparison with the types of Walker in the British Museum. They proved to be identical with a species described by Mr. Walker from this country under the name of *Teras rostrana*, but it is now placed in the genus *Tortrix* as above.

The larva, which much resembles that of *Tortrix flavedana* Clem., is 18^{mm}. (.7 inch) long, dark yellowish green, somewhat darker than the larva of *T. flavedana*, with a darker dorsal stripe and an indistinct subdorsal line, the space between these being slightly grayish. Anal plate of the same color as the body. Head and thoracic plate polished brown.

The larva rolls the edges of the leaves ot orange by means of silken threads, forming a kind of tube, in which it remains except when disturbed or feeding. In this tube it transforms into a pupa, and from this the perfect insect emerges.

The pupa does not differ materially from that of *T. flavedana*, except that it is larger, being 11^{mm} (0.43 inch) long.

The sexes of the perfect insect differ considerably in the markings of the fore wings. All the wings of both sexes have the general ground color of cork. Fore wings of the males with a dark brown stripe along the front or costal edge, expanding into a large spot of the same color just before the end of the wing. A few elevated tufts of dark brown and yellowish are scattered over the surface. Fore wings of the female with very minute dark brown tufts arranged in more or less distinct lines running obliquely across them. Expanse of wings of males 18^{mm} (.75 inch nearly), of females, 20^{mm} (a little over .75 of an inch).

THE CLOVER-SEED CATERPILLAR.

Grapholitha interstinctana, Clemens.

Order LEPIDOPTERA; family TORTRICIDÆ.

SYNONYMY.

Stigmonota interstinctana Clems., Proc. Acad. Nat. Sci., Phila., 1860, p. 351.
Dicrorampha scitana Walker, Cat. Lep. Het. 413.
Grapholitha distema Grote, Bull., Buffalo Soc. Nat. Sci., vol. i, p. 92.
Grapholitha interstinctana. (Zeller.)

Eating into the young flower buds, and, later, into the seed vessels of red clover, small cylindrical caterpillars 6-8mm long, dirty greenish white in color, spinning white cocoons in the flower heads, and eventually transforming to small brown moths.

In July, 1874, I first noticed, at Ithaca, N. Y., that the heads of red clover were frequently infested by small greenish white larvae, rarely more than one to a head, which were eating into and destroying the seed. There was usually but one larvae in a single head, but occasionally one would be found which contained two. Nearly all the seed in the head was destroyed by the larva in the course of its growth, and from 15 to 20 per cent. of the heads seemed to be infested, so that it really bid fair to be quite a serious pest. Many of the affected heads were collected and placed in a breeding jar with a view to ascertaining the duration of time in the different stages, and also such facts as to habits as could be seen.

From the 17th to the 10th of July the larvæ began leaving the heads, which were so injured and dried from their work that the flowers readily fell from the receptacle on handling. The majority of the larvæ spun white cocoons among the flowerets, to which were attached bits of frass and particles of the flower head, so as to disguise them and render it very difficult to discover them. Some few of them, which happened to be near the sand in the bottom of the jar, burrowed beneath the surface for a fraction of an inch and there spun their cocoons. That this, however, was not a natural habit, and was due to the abnormal condition in which they were placed, was shown later.

The insects remained in the pupa state for from twenty to thirty days, and the moths began to issue after the 12th of August. Before giving forth the moth, the pupa worked its way entirely out of its cocoon.

The moths were very small and dark brown, nearly black in color, the wing expanse being from 8mm to 10mm (.31 to .39 inch). They were characteristically marked by two small, parallel, excurved, short silvery streaks at the middle of the hind border of each fore wing, so that when the wings are closed the lines meet and have the appearance of two crescent-shaped streaks. I was unable at that time to ascertain the number of broods, although there was probably one generation after the one just mentioned, nor was I able to ascertain in what state the insect wintered.

Early in May, 1879, specimens of the same moths were swept from clover in the department grounds at Washington, and on June 7 the first larvae were found. They were then about 5mm (.19 inch) in length, not far from full grown. Within a few days of this date they had spun their cocoons, and on June 29 the first moths of this brood issued. From the rate of growth we would argue three broods in a season in the lati-

tude of Washington. The insects probably hibernate in the pupa state, although of this we have no proof.

A small light brown ichneumonid parasite was bred from one of the cocoons. It was identified by Mr. Cresson as *Phanerotoma tibialis*, Hald., and was originally described by Haldemar in the Proc. Acad. Nat. Sci., Phila., vol. iv, p. 203, as *Sigalphus tibialis*. It is 3.5^{mm} long, light brown in color, with a large yellowish spot on the back of the abdomen.

As to remedies, the cutting of the hay crop of clover in early June, as for the clover seed midge (*Cecidomyia leguminicola* Lintner), would, in all probability, destroy the majority of the immature larvae of the first brood.

We append a technical description of the earlier stages of this insect, followed by Mr. Grote's description of the adult, which is much better than Clemens:

Larva: Length 8^{mm}, subcylindrical, tapering slightly at each end; legs and proplegs normal. Color, dirty white, often with a greenish tinge; head, dark brown, trophi, black; prothoracic shield, yellowish with a brown hind border interrupted in the middle. Body with many delicate whitish hairs. The dorsal piliferous tubercles of each segment arranged in two pairs, of which those of the anterior pair are closer together than those of the posterior pair.

Pupa: Length, 5^{mm}, moderately slender. Wing sheaths extend to sixth abdominal segment; antennae and posterior tarsal sheaths ending at tip of wing sheaths, the tarsal sheaths being a trifle the longer. Dorsum of each visible abdominal segment except the last with two transverse rows of backward directed teeth, those of the anterior row being strongest. Anal segment blunt at tip, with six stout blackish excurved hooks at its posterior border, two dorsal and four lateral, none ventral; also a number of very delicate hooked filaments. General color rather light-brown, darker on wing covers and dorsum of thorax.

Adult: "A tiny blackish silky species, resembling the European *compositella*, but with only two white lines on the internal margin of the primaries. Eight white costal marks disposed in pairs, crowded towards the black apices, and becoming straighter and shorter; the first pair more oblique and divaricate. A silvery subterminal streak runs from opposite the cell over the median nervules tapering to internal angle. (This streak cannot be seen in some lights.—J. H. C.) Secondaries fuscous with pale fringes. Beneath irridescent, greenish in certain lights, with minute costal dots over the outer half of the wings. Body scales beneath whitish.

Habitat: New York, Pennsylvania, District of Columbia.

THE SULPHUR-COLORED TORTRICID.

(*Tortrix sulfureana* Clem.)

Order LEPIDOPTERA; family TORTRICIDAE.

SYNONYMS.—*Croesia? sulfureana* Clem.; *Conchylis gratana* Walk.; *Croesia? fulvoroseana* Clem.; *Croesia? Virginiana* Clem.; *Croesia? gallivorana* Clem.; *Tortrix sulfureana* Robs.; *Tortrix* (*Dichelia*) *sulfureana* Zell. and variety *Belfrageana* Zell.; *Cenopis gracilana* Wlsm.

Drawing together the leaflets of red and white clover and feeding on the tissues, a small yellowish green larva, which transforms into a brownish colored pupa, from which emerges a small sulphur yellow moth with purplish red markings.

During the summer of 1879, small yellowish green larvae were found in considerable numbers in the District of Columbia, feeding on red clover (*Trifolium pratense*), and also on white clover (*Trifolium repens*). The larvae were first found May 13, folding the leaflets of red clover into a kind of tube by drawing the edges together with silken threads, which was spun for this purpose. Sometimes they spin two leaflets loosely together, or to the flower head when they are nearly full grown. They issue from either end of this tube, and feed upon the surrounding

foliage, of which, when the larvae are young, they eat only the under surface, leaving the veins and the epidermis of the upper side intact, but when nearly full grown they eat irregular holes through the surrounding leaflets and flower heads.

These larvae are very active when disturbed, and wriggle from their tubes, suspending themselves by a silken thread, by which they can let themselves down to the ground, and if further disturbed, they wriggle about with great energy.

Some of the larvae changed to pupae on the 19th of May in folded leaves, which they lined closely with silk. The perfect insects began to emerge on the 19th and continued until June 3, when the last of this lot came out. On the 20th of June several larvae were found feeding in a similar manner to the above on the leaves of white clover on the department grounds. At this time they were less than half grown, but transformed to pupae by the 1st of July, the perfect insects emerging from July 5 to 14. About the middle of August more of these larvae were found on red clover, some nearly grown, others quite small. These became full grown in a short time, passed their transformation, and emerged perfect insects from September 1 to 16. Those which changed to pupae September 1 emerged on the 10th.

From the data now before us, it is more than probable that there are three generations in a year in the latitude of the District of Columbia, the first appearing in the perfect state about the last of May, the second in the early part of July, and the third in the early part of September. One full-grown larva was found on clover October 21; and it may be that this species hibernates in the larvae state, the same as the codling moth. Professor Fernald informs us that he does not think there is more than one generation in Middle and Northern Maine.

The perfect insect is of a bright sulphur or golden yellow color, with a Y-shaped purplish red mark across each fore wing, and more or less of the same color along the front or costal and outer border. Hind wings varying from light yellowish to brown. Expanse of fore wings half an inch or a little more.

Distribution.—These insects are very widely distributed through the United States, having been reported from Maine to Florida, and as far west as Texas and Missouri.

Food-plants.—Besides the plants mentioned above—red and white clover—the larvae of this species were found and fed on locust, strawberry, and grape. Some of the larvae were also fed upon the cotton plant by way of experiment. Specimens were received from Dr. R. S. Turner, Fort George, Fla., which fed on orange. Mr. B. D. Walsh bred this species from the willow gall, *Salicis-brassicoides*, in Illinois.

Natural enemies.—One of the larvae on clover was found to be infested with a Hymenopterous parasite, which, however, failed to emerge.

We here introduce descriptions of the larva and pupa:

Larva.—Length when full grown 14^{mm}, cylindrical, slightly fusiform. Head and thoracic plate very pale honey yellow, the rest of the body yellowish green with the alimentary canal showing dark green through the dorsum. Eyes, third joint of antennae, and tarsi, blackish. Piliferous tubercles slightly paler than the rest of the body, each one being surmounted by a brownish hair. Spiracles green with a brown ring.

Pupa.—Length 8^{mm}. Color, dark shining brown, lighter at the end of the wing covers and the parts covering the palpi and base of the antennae. Front rounded and smooth. Abdominal segments on the dorsal side armed with two transverse rows of small spines inclined backward, those on the posterior edge of each segment finer and closer than those of the other row. Abdomen terminated by a protuberance, flattened above, rounded at the end, hollowed out underneath near the base, and armed with two fine hooks on each side, and four from the end.

THE RUSTY BROWN TORTRICID.

(*Tortrix flavedana* Clem.)

Order LEPIDOPTERA; family TORTRICIDAE.

SYNONYMS:—*Platynota flavedana* Clem.; *Teras tinclana* Walk.; *Tortrix concursana* Walk.; *Tortrix flavedana* Robs. ♂; *Tortrix laterana* Robs. ♀; *Tortrix (Platynota) flavedana* Zell.

Drawing together and feeding upon the leaves of red and white clover, strawberry, and raspberry, a small greenish larva which transforms into a brownish colored pupa from which emerges a dark or reddish brown moth, with minute tufts of scales on its fore wings.

On the 20th of June the half-grown larvae of this species were found feeding on the leaves of white clover (*Trifolium repens*) in the department grounds at Washington. On the 18th of August the young hatched from a lot of eggs found on a leaflet of red clover (*Trifolium pratense*). These eggs were of an oval form much flattened, of a greenish white color, and were deposited more or less overlapping each other in considerable number in a cluster near the central part of the upper side of the leaflet.

The young larvæ were about one thirty-second of an inch in length, of a pale yellow color, with a blackish head and pale brownish thoracic plate. August 25 these larvae shed their skins or molted the first time, each one forming a tube of fine silk within a folded leaf in which it remained when not feeding. The second molt occurred on the 28th and 29th of August, after which they were quite yellow, with a faint greenish tinge, with a pitchy black and highly polished head and thoracic plate. The third molt occurred from September 1 to 3, after which the head and thoracic plate were light brick-red color. September 4 one of the larvae molted the fourth time, and the others a little later. On the 10th they transformed to pupae and the perfect insects emerged September 24. From this lot of eggs were raised the form known as *Tortrix flavedana* Clem., and also the form described by Mr. C. T. Robinson as *Tortrix laterana* ♀, thus proving that these insects which Robinson regarded as distinct are, as Zeller believed, the different sexes of the same species.

From the studies made here on this species it would appear that there are two generations in a year, if not three, one appearing earlier than any of the above observations, possibly.

The sexes differ considerably, but the males are of a dark brown color over the larger part of the fore wings, with several minute tufts of scales over the surface, the outer portion and base of the wing reddish yellow; hind wings dull rust red. Expanse of wings five-eighths of an inch. Females dull rust red, the fore wings with three oblique bands across them, nearly obliterated in places. Expanse, three-fourths of an inch.

Distribution.—These insects have been reported from Maine, Massachusetts, New York, Pennsylvania, District of Columbia, Missouri, and Texas.

Food-palnts.—Besides red and white clover, these insects feed also on strawberry and raspberry.

Natural enemies.—Two species of Hymenopterous parasites were bred from larvae of this Tortricid—*Microgaster zonaria* Say and a species of Bracon.

The larva and pupa are described as follows:

Larva.—Full-grown larva about half an inch long; color, dark yellowish green; piliferous tubercles a little lighter and faintly polished. Head and thoracic plate reddish, first joint and antennae, labrum and anterior margin of thoracic segment white. Anal plate concolorous with the body, sometimes a little lighter; near the anterior margin of the plate are three dusky spots, one in the middle, the others elongated and placed a little behind and directed obliquely forward and outward. The tip of the segment has eight short and stiff bristles, and the whole body is covered with minute brown granulations. The under side a little lighter than above.

Pupa.—Length, 8^{mm}. Brownish, of the usual form; terminal protuberance of the abdomen somewhat flattened above and below and slightly hollowed out on the flattened sides near the base; armed with the usual hooks, two on each edge, near the end, and four at the extreme apex. Abdominal segments on the dorsal side armed on each edge with the usual short spines.

SERICORIS INSTRUTANA (Clem.)

Order LEPIDOPTERA; family TORTRICIDAE.

SYNONYMS.—*Sericoris instrutana* Clem. (1865). *Sericoris poana* Zell. (1875).

Folding up and feeding on the leaves of red clover, a small ocher yellow larva which transforms into a light brown pupa, from which emerges a small dark brown moth with two lighter oblique bands across each fore wing.

The larva of this insect was found feeding on the leaves of red clover (*Trifolium pratense*) on the department grounds August 6, and folding up the leaflets, forming a tube-like passage which it lined inside with silk, and on the 18th it transformed into a light brown pupa, the moth emerging on the 25th of the same month.

The moth has quite a close resemblance to the raspberry leaf-roller (*Exartema permundanum* Clem.) in the general color and marking of its wings, but is much smaller, the wings expanding only half an inch.

Professor Fernald informs us that this species is quite common in Maine, and it is also reported from Massachusetts, New York, Virginia, and Ohio.

THE PALE CLOVER TORTRICID.

(*Tortrix discopunctana*, Clem.)

Order LEPIDOPTERA; family TORTRICIDAE.

A pupa of this species was found, August 9, in a silken cocoon within a rolled-up leaf of clover on the department grounds, which emerged August 14. On the 2d of September another pupa was found within a folded leaf of clover, which emerged September 20. From this we may safely infer that this Tortricid is destructive to clover, and that there may be several generations in a year at this place.

The pupa is of a light yellowish brown color, 6.5^{mm} (.25 inch) long, with the usual row of minute spines on each edge of the dorsal side of the segments, and the terminal protuberance of the abdomen rounded on the dorsal side but excavated on the other and armed at the tip with minute hooks, by means of which the pupa adheres to the cocoon when the perfect insect escapes. The moths are of a dull yellowish color with two more or less distinct reddish brown lines across each wing, with brown shadings on the outer side and several dark brown dots along the costa on forward side of the wing, and one on the disk in the middle of the wing between the cross lines. Sometimes the cross lines and shades are wanting. Hind wings pale yellowish. Expanse of wings 6.5^{mm} (.25 inch).

THE VARIABLE OAK-LEAF CATERPILLAR.

(*Heterocampa subalbicans*) Grote.

Order LEPIDOPTERA; family BOMBYCIDAE.

Feeding upon the leaves of oak, basswood, and hawthorn, a brownish or yellowish green caterpillar something over an inch long with a few coarse hairs on its body, transforming under ground and eventually becoming an ashy gray moth.

During the past season a great amount of damage has been done in at least two counties of Arkansas (Garland and Saline) by this worm, by the destruction of the foliage of the oak forests. The first specimens were received through the Smithsonian Institution from Mr. Charles Matthews, of Hot Springs, October 20. In January a very interesting communication was received from Mrs. William S. Thomas of Alexander, Saline County, in which it was stated that the worms were to be found in immense numbers. A disease of swine synchronous with the appearance of the worms was supposed by the people of that section to be caused by the swine feeding upon the insects. But the symptoms of this disease were those of swine plague, or of some virulent blood-poison disease; and it is not probable that the unusual food of the animals was in any way connected with it.

There are probably two broods of the variable caterpillar in the course of the season, although but one, the fall brood, seems to have been noticed. The moths appear in the latter part of April or in early May, and between that time and late September, when the principal damage is done by the worms, there is abundant time for two broods of caterpillars.

In the District of Columbia for the last two years these larvae have been noticed very abundantly upon oak, hawthorn, and basswood, and doubtless feed upon other plants. In late September they had reached their full size and entered the ground, where, as we gather from Mrs Thomas's letter, they lie most of the winter before transforming.

The most obvious remedy for the injuries of this insect is the destruction of the larvae by burning the leaves upon the ground in the latter part of September, just as the larvae are dropping from the trees. This could probably be done in most places without danger to the forest and without injury to the mast.

Should the damage done by the worms be sufficiently great to warrant the expense of trap lanterns, to be used in May to destroy the moths, undoubtedly their numbers could be greatly lessened. For description of trap lanterns, with remarks upon their use, see page 330 of the report for 1879.

The moth expands about 4^{cm} (a trifle over $1\frac{1}{2}$ inches), and is of a delicate gray color, the fore wings mottled with a dusky tint, and the hind wings of a light brown, darker along the hind border.

The caterpillar has never to our knowledge been scientifically described, and we therefore append the following:

DESCRIPTION OF LARVA.

Variety a.—Length when full grown 40^{mm} ($1\frac{1}{2}$ inches), rather slender, subcylindrical. Head pale green with a deep purplish lateral line bordered below with a pure white line; dorsum of abdomen bluish-green with a narrow white dorsal line; the green dorsum is bordered each side by a narrow scarcely noticeable yellow line running from the head to the 4th segment, from which point it is purple to the end of the

body; this line is bordered below by a very distinct pure white subdorsal band; the sides are bluish with dark purplish spots; stigmata orange; below the stigmata a faint interrupted yellow band; the dorsal and lateral piliferous warts are yellowish; subdorsal whitish. The first thoracic segment has two yellow dorsal tubercular spots; segments 2 and 3 have each a yellow dorsal double wart, and the first abdominal segment has two quite conspicuous red piliferous tubercles; the penultimate segment is somewhat gibbous above and bears two small reddish piliferous tubercles.

Variety b.—Head dark yellow; dorsum of body purplish with paler mottlings; dorsal line white; the subdorsal white line interrupted on abdominal segments 3 and 6; the sides rather browner than the dorsum; lateral line yellow and more distinct than in variety *a*. Stigmata orange; the first thoracic segment has the yellow tubercle, but segments 2 and 3 have only the lower one of the double tubercles yellow. In other points it resembles variety *a*.

Variety c.—Head very pale yellow; dorsum pale grayish; dorsal white line bordered each side by a narrow purplish line. The subdorsal band consists of a narrow purple line, an indistinct yellow line, and a broad white band; the subdorsal lines approximate on the thoracic segments as in other varieties; the lateral line is yellow, distinct, and uninterrupted; sides slightly darker than the dorsum and specked with purplish spots.

THE LOCUST-TWIG BORER.

(*Ecdytolopha insiticiana* Zell.)

Order LEPIDOPTERA; family TORTRICIDAE.

Boring in the twigs of locust, sometimes causing a thickened growth of the stem for the distance of from 1 to 3 inches, a pale whitish larva with brownish head, which cuts its way out when full grown, descending to the ground and transforming into a yellowish brown pupa in curled leaves upon the surface, and finally emerging a dark brown moth with dirty pinkish-white on the outer portion of the fore wings.

During the latter part of September the terminal shoots and twigs of several varieties of locust (*Robinia pseudacacia* vars. *crispa*, *tortuosa*, and *inermis*) growing on the department grounds were observed to have an abnormal thickened growth from 1 to 3 inches in length, and enlarging the stem at this place to nearly twice the normal size, the enlargement being quite uneven and irregular. An examination of some of these diseased stems disclosed the fact that a lepidopterous larva was boring along the central part of the stem and feeding upon the tissues. This larva when full grown is about half an inch in length, of a yellowish color, somewhat darker on the dorsal line. Head dark brown; thoracic plate light honey yellow. On the 1st of October these larvae left the stem through holes which they had cut out to the surface, and descended to the ground, where they transformed to pupae among the dry and curled leaves which had fallen, and in which they spun thin but tough silken cocoons. Sometimes they crawled between a fallen leaf and the ground, when the cocoon adhered to the leaf on one side and was thickly covered with grains of sand on the other.

The first moth emerged October 17, and others from the 20th to the 27th. An examination of a large number of shoots proves that this insect deserts its burrow to transform on the ground.

Some of the shoots were badly infested; ten places where larvae were at work were counted in one of them, and the whitish excrements hung in clusters from the holes, which were almost always between two of the thorns, where the egg had probably been deposited. These shoots, however, were not enlarged.

This species was described under the above name by Prof. P. C. Zeller, of Stettin, Germany, from specimens received of Mr. Burgess, who took them in Massachusetts in June and July. Professor Fernald informs us that he has received them from Mr. Morrison taken in Colorado.

The only remedies we can suggest are to cut off the infested twigs *before* the escape of the larvae and burn them. If for any reason this has not been done, it would be well to collect carefully all the leaves beneath the infested trees and burn them to destroy the insects while in the pupal state. This should be done, however, *after* the escape of the larvae from the trees and *before* the moths emerge, or not far from the 8th of October at this place.

The moths are of a dark ashy brown color on the fore wings, with a large patch of a dull pinkish white color on the outer part, with several small black spots near the middle of this patch. Hind wings a little lighter than the basal portion of the fore wings. Expanse 18–20^{mm} (about .75 inch). The larva and pupa are characterized as follows:

Larva.—Length 13^{mm}. General color, reddish straw yellow. Head light brownish, tips of mandibles and a small spot about the eyes, blackish, thoracic and anal plates light honey yellow. The piliferous tubercles on the dorsum are greatly expanded laterally so as to give them an elliptical form; the anterior pair on both the third and fourth segments are so expanded that the distance between them is only equal to their length, the posterior pair on these segments nearly or quite obliterated. Anterior warts of the fifth to eleventh, inclusive, more rounded and brought close together at the dorsal line; those of the posterior side of these segments, fusiform, the length quite equal to four times the thickness, and separated from each other by a small space on the first of these segments, but approaching more and more; they touch each other on the dorsum of the more posterior ones. The dorsal tubercles of the twelfth segment are so fused together as to appear like two transverse elevated bars. The remaining warts of the body are as usual, but considerably enlarged, and each surmounted by a fine yellowish bristle.

Pupa.—Length 10^{mm}. Color yellowish brown. Abdominal segments, on the dorsal side, armed on each edge with the usual rows of spines. Anterior end rounded and smooth, posterior end bluntly rounded, with a row of spines like the larger ones on the segments before, extending two-thirds the way around.

THE LOCUST-LEAF PHYCID.

(*Pempelia contatella* Grote.)

Order LEPIDOPTERA; family PYRALIDAE.

Drawing together and feeding on the leaves of locust, a small green larva with black head and thoracic plate, transforming into a dark brown pupa, from which emerges a small reddish gray or blackish gray moth.

On the 29th of August several larvae were found on the locust (*Robinia pseudacacia*), in the department grounds, drawing the leaves together, the side of one to that of another.

The smallest larvae at this time were about one-eighth of an inch long, yellowish green, with jet black head and thoracic plate. Those full grown were nearly an inch in length, of a grayish green color above, more or less tinged with pink, especially on the third and fourth segments, and between the folds; under side pea green. Some of the larvae were of a yellowish green color, darker green anteriorly, head yellowish brown with irregular black blotches, thoracic plate green, with a few small black spots, anterior margin yellowish, posterior pale brownish.

These larvae transformed to pupae between the 5th and 8th of September and emerged in the following May.

As none of the pupae of this insect could be found among the leaves on the tree a careful search was made on the ground beneath, where a pupa was found spun up in a tough silken cocoon to which earth, fragments of leaves, and dry grass were adhering in such a manner as to completely conceal it.

The moths expand 20^{mm} to 26^{mm} (nearly 1 inch). The fore wings are

blackish and gray, with a shading of red at the base and near the middle of the wing below the fold. These reddish shades are sometimes wanting. Base of the wing usually whitish gray.

Mr. A. R. Grote, who published this species originally, also described a variety of it under the name of *quinquepunctella*, and stated that it might be a distinct species from *contatella*. Most of the examples mentioned above agree with the typical *contatella*, while one of them is undoubtedly the var. *quinquepunctella*.

Distribution.—This species has also been reported from New England, New York, and London, Ontario.

Remedy.—Gather all the leaves beneath the trees after September and burn them.

Pupa.—Length 10^{mm}, rather stout. Color chestnut brown. Anterior end rounded; posterior with a minute beak, curving downward slightly, and armed at the end on each side with a sharp, stout spine extending obliquely out and downwards. In a row between these, at equal distances, are four slim filaments much longer than the spines and hooked at the end. The abdominal segments are covered above and below with coarse punctures, except on the posterior edge, while the wing covers, head, and thorax above are impressed with irregular striae.

PEMPELIA GLEDITSCHIELLA Fernald (new species).

Order LEPIDOPTERA; family PYRALIDAE.

Drawing together and feeding upon the leaves of the honey locust, a greenish yellow larva, which transforms on the ground into a dark brown pupa, from which emerges an ashy gray moth, with a black band across the basal third of the fore wing.

A large number of larvae, in different stages of growth, were found August 12, drawing together and feeding on the leaves of the honey locust (*Gleditschia triacanthos*) on the department grounds. The general color was greenish yellow, though there was considerable variation among them. These larvae transformed to pupae from the 3d to the 15th of September. When full grown they descend to the surface of the ground, where they spin a loose cocoon of coarse gray silk, which is completely covered with fragments of dried grass, leaves, or other substances, which so conceals them that they are difficult to be found.

Two of these moths emerged in the latter part of September, but the most of them during the last half of the following May and early part of June, so that it is more than probable they pass the winter in the pupa state on the ground under the trees.

We give below a description of the species by Prof. C. H. Fernald:

PEMPELIA GLEDITSCHIELLA Fernald (n. species).

Head, palpi, antennae, thorax above and beneath, legs and fore wings light ashy gray. Most of the examples have a purplish tint on all these parts, deepest on the thorax above and basal portion of the fore wings. A black dash broken in the middle crosses the thorax behind the middle, starting from under the patagiae on either side. Fore wing with a broad black band crossing it at the basal third, which consists of three or more lines of raised black scales, the outer one curving obliquely across from the costa to the median vein, sometimes a little beyond, then inward to vein one, where it forms an obtuse angle, the apex pointing towards the base of the wing; then outwardly, taking the same general course as the first part of the line, to the inner border; within this, and separated by a very narrow line of the general color of the wing, are two diffused black lines of raised scales; the inner one seems to fuse with the one beyond before reaching the costa. This band is followed by a lighter shade, which extends as far as the discal dots, of which there are two of jet black raised scales on each angle of the cell; the lower one being a little more remote from the base of the wing. Outer line scarcely visible in most of the examples, of the general color of the wing, dentate throughout its course, and bordered on each side with a very pale shade of brown, which is darker, and broadens on the costa. A row of terminal black dots. The middle of the wing sparingly sprinkled with black scales. Fringes

concolorous with the wing. All the wings beneath, hind wings above, and abdomen light brown. All the tibiae and joints of the tarsi with whitish.

Expanse.—19mm–22mm.

Habitat.—District of Columbia. Described from fifteen males and eleven females.

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Larva.—When full grown, 16mm in length, greenish yellow, with three longitudinal brown stripes on each side of the dorsal line, extending from the thoracic to the anal plates, and alternating with narrow, lemon-yellow stripes, the last one being on the line of the spiracles. Head, thoracic, and anal plates with more or less brown marks and blotches. There is great variation in these larvae in the intensity of the brown markings, but they can readily be recognized by a black lunate spot on the under side of the subdorsal tubercle of the third segment, behind the thoracic plate.

Pupa.—Length 10mm, dark brown, rounded anteriorly, posterior end with a small spine on each side extending obliquely out and backward, the end curving backward. In a line between these stand four fine hooks, much longer than the lateral spines. Abdominal segments, except the last, covered with coarse punctures, except on the posterior edge. Wing covers reaching to the fourth abdominal segment.

TETRALOPHA DILUCULELLA Grote.

Order LEPIDOPTERA; family PYRALIDAE.

Feeding upon the leaves of the terminal twigs of pine, which they draw together loosely with silk, and in which they deposit their excrements, the whole forming an irregular mass nearly 3 inches long and 2 in thickness, stout, dull, greenish yellow or drab-colored larvae, transforming into brownish pupae, from each of which emerges a moth with dark brown and gray markings.

Some of the terminal twigs of pine (*Pinus taeda*) infested by the larvae of this insect were collected by myself in January, 1880, near Jacksonville, Fla. The appearance of these infested twigs is somewhat striking; the leaves around the end are loosely held by threads of silk, which also holds the excrements of the larva in a more or less irregular mass, varying from 1 to 3 inches in length and from 1 to 2 in thickness.

The larva is about eight-tenths of an inch in length, rather stout, of a greenish yellow or drab color, with two very distinct, quite broad black dorsal stripes, and a narrow one on each side.

When mature the larva descends to the ground, where it spins a loose cocoon of yellowish brown silk, to which is attached a covering of grains of sand or other loose materials, and within which it transforms to a pupa, in which state it passes the winter.

The moths from the larvae mentioned above emerged during the following April. They have an expanse of about an inch. The fore wings are dark brown, nearly black, on the basal third, beyond which is a broad, light gray band crossing the wing, while the portion beyond the band is dark brown followed by gray. Hind wings dark ashy, with a silky luster. The colors are not as clear in the males.

Mr. Grote described this insect from examples taken in New York, and stated as follows: "The species recalls the figure of *Hemimatia scortealis* Led., but the wings are larger, and it does not seem possible that Lederer should have overlooked the strong generic characters." It certainly does agree closely with Lederer's description and figure, and may yet prove to be that species, but Lederer's types must be examined to make sure of this, for it is possible that he made a mistake in locating his species. A species of Microgaster was found parasitic on this insect.

We add the following description of the larva and pupa:

Larva.—Length when full grown 20mm, cylindrical, slightly tapering posteriorly and quite stout, of a dull greenish yellow color, somewhat paler beneath, with a nar-

row black stripe on each side about twice the width of the last, and equally distant from it and the middle of the dorsum. This stripe extends from the thoracic to the anal plate. The head, thoracic, and anal plates are of the same ground color as the body. Eyes and end of mandibles black; several irregular black bands on each side of the head, extending from the posterior side forward to about the middle; thoracic and anal plates with a few scattered brown dots, the latter with an irregular row of black points across the anterior side.

Pupa.—Length 11^{mm}, robust, light brown, rounded at both ends, the posterior armed with a cluster of fine hooks; the abdominal segments are covered with coarse punctures except on the posterior edge. Wing covers extend to the end of the 4th abdominal segment.

TORTRIX POLITANA? Haw.

Order LEPIDOPTERA; family TORTRICIDAE.

Feeding upon the leaves of white pine, which it draws together into a kind of tube, a small yellowish green larva with a black head and olive green thoracic plate, which transforms into a light brown pupa, from which emerges a rusty-red colored moth.

On the 15th of October, the department received from Professor Gage, of Ithaca, N. Y., a number of the tips of branches of white pine (*Pinus strobus*) which were infested with the larvae of a species of Tortricid. From six to ten of the terminal leaves were drawn together lengthwise, forming a kind of tube, which was lined inside with delicate white silk. Sometimes the leaves of one fascicle were drawn together, but more frequently those which were near each other from different fascicles. The tube is open at each end, the outer being cut off squarely or obliquely, very often leaving two or more of the leaves untouched.

This tube seems to serve as a protection to the larva, from which it comes out to feed upon the ends of the very leaves of which the tube is composed. In this way the leaves are shortened, the larva feeding upon one after another only at the end, thus shortening them gradually until the larva is fully grown, when there are sometimes one or more of the leaves left untouched. Those first attacked gradually become dry and yellow, loosening from their bases, and are only held in place by the green ones.

The full-grown larva is three-eighths of an inch long, of a yellowish green color, with dark or blackish head and olive green thoracic plate.

The moths emerged from the 26th of December to the 30th of January, and have the head, thorax, and fore wings of a dull rust-red color, with two oblique paler bands, one a little before the middle, the other beyond, parallel to it, crossing the fore wings. Hind wings and upper side of the abdomen silky gray. Expanse of wings, half an inch.

These moths are not easily disturbed, and if the branches upon which they are sitting be shaken they drop to the ground, feigning death, not even moving when touched.

Specimens were sent to Professor Fernald for determination, who replied as follows:

This species has been determined for me by Professor Zeller as *Tortrix politana* Haw. It feeds here on white pine as you describe, but Wilkinson gives *Myrica gale* as the food plant in England, and Heinemann gives *Ranunculus acris* and *Centaurea jacea* as food plants in Germany. If our species is really identical with the European *T. politana* it must be very polyphagus.

He further says:

I am not able to learn that it has ever been observed feeding upon any of the *Coniferae* in Europe.

We append the following descriptions:

Larva.—Length 9mm. General color yellowish green, with coarse brown granulations on the dorsal surface. Tubercles as usual. Head dark, almost black. Thoracic plate olive green.

Pupa.—Length 8mm. Color light brown, with the wing cases somewhat greenish, front smooth and rounded, abdominal segments above armed with the usual spines. Tip of the abdomen prolonged into a beak-like protuberance, which is grooved longitudinally and impressed with numerous coarse punctures and terminated by the usual minute hooks.

As Professor Fernald thinks there is still a chance that this is not identical with the European *Tortrix politana* Haw., he has prepared the following description for this report.

Imago of Tortrix (Lophoderus) politana. Haw.—Alar expanse 13-14mm. Head, palpi, thorax above, and upper side of fore wings yellowish red. Thoracic tuft, basal patch, oblique and apical bands dark rust-red. The space between the basal patch and central oblique band is narrow, scarcely lighter than the basal patch, and indicated by a lighter edging on each side of the space which begins at the basal third of the costa and extends obliquely across the wing to the middle of the hinder margin. The space beyond the central band is similar to the last, beginning near the outer third of the costa and extending obliquely across the wing to the anal angle. The outer margin in some specimens is of the same color as the interspaces, and the costa is more or less flecked with light yellow. Fringe yellowish, with grayish scales at the anal angle. Hind wings and abdomen above, silky gray or slate color; under side and fringes lighter. Under side of fore wings light fuscous, with lighter yellowish diffused spots along the costa and outer border. Under side of abdomen and thorax light straw yellow, as are also the legs. Fore and middle legs annulated with brown.

THE SILVER-PINE TORTRICID.

(*Grapholitha bracteatana,* Fernald [new species].)

Order LEPIDOPTERA; family TORTRICIDAE.

Infesting the cones of *Abies bracteata,* a small Tortricid larva. After transforming, the pupa protrudes itself nearly two-thirds of its length, and from this emerges a small dark-colored moth with white and metallic markings.

On the 14th of August, 1880, cones of the *Abies bracteata* were sent to this department by Mr. George R. Vasey, from Jolon, Cal., one of which was infested with Tortricid larvae. Three of the moths emerged on the 13th of September, 1880, one on the 15th, and another on the 20th.

The seeds of this cone, as well as those of others sent at the same time, were infested with Cecidomyid larvae. The Tortricid larvae worked only in the scales of the cone, while the Cecidomyids were confined to the seeds.

Mr. Vasey, who sent the cones, states that "the *Abies bracteata* Nutt. locally called silver pine, extends from the northern boundary of San Luis Obispo County forty miles northward, in cañons on both sides of the Santa Lucia range. It is a handsome and striking tree, 100 to 150 feet high, in shape pyramidal, with an elongated peak. The white under surface of the leaves produces a *silvery sheen* when the sun shines upon them at the right angle."

The following description of this moth has been written for this report by Prof. C. H. Fernald:

GRAPHOLITHA BRACTEATANA Fernald (n. sp.):

Head, palpi, thorax above, and basal third of fore wings dull ocher yellow, inclining to cinereous on the thorax and base of the wings in certain lights; last joint of palpi very small, somewhat darker; legs, thorax, and abdomen beneath straw-yellow; outer side of the tibiæ and the basal portion of each joint of the tarsi pale cinereous.

Fore wings externally ocher yellow, overlaid with dark brown scales. Costa marked

with fine geminate white spots, from which are continued metallic blue stripes. The first costal spot begins a little before the middle, the second a little beyond the middle, the others following at about equal distances from each other towards the apex, alternating with and cut by dark brown, the third and fourth not geminate in some examples. A triangular white spot rests upon the middle of the hinder border of the wing, divided at the base by light brown, extending obliquely up and outward to the middle of the wing, where it meets the metallic stripe from the first costal spot. The metallic stripe from the second costal spot extends obliquely for a short distance towards the anal angle, where it is joined with the one from the third costal spot, then curving downward they extend as one stripe nearly across the wing, forming the inner boundary of the ocellus. The metallic stripes from the two outer costal spots also unite a little below the costa and extend across the wing parallel with the last, forming the outer boundary of the ocellus and, curving inward, unite with the other beneath the ocellus, and just above the anal angle. The dark brown between the costal spots extends down between the metallic stripes, suffusing more or less the ocher yellow of the wing. Ocellus straw-yellow, with three parallel dark brown dashes, sometimes only represented by one or more dots. The basal portion of the wing forms an acute angle near the middle of the cell, and is somewhat suffused with brown where it rests against the first oblique stripe and the white spot of the inner border. Fringe metallic blue or purple, according to the light, with a basal dark brown line and a few white scales below the apex.

Hind wings and abdomen above, and under side of all the wings, fuscous; fringes of hind wings a little lighter. Costal spots of the fore wings reproduced beneath.

Expanse.—Female, 12 ^{mm}; male, 9–10 ^{mm}.

Habitat.—California.

Described from three males and two females, one male and one female in my collection, the rest in the collection of the Department of Agriculture.

C. H. FERNALD.

THE CATALPA POD DIPLOSIS.

(*Diplosis catalpae* n. sp.)

Feeding in the seed pod of *Catalpa bignonoides* are many small orange-colored maggots, causing the seed to rot and the pod to turn brown in midsummer.

In the early part of August the unripe and normally green pods of the Indian bean (*Catalpa bignonoides*) upon the department grounds were noticed in many cases to have partly turned brown in a strange manner; one-half or more of the pod remaining green while the remainder appeared to be dry and of the color which it usually has when ripe. Upon opening one of these abnormal pods, the mass of seeds was found to be fairly filled with active, footless, little yellow maggots, none of them more than 3.25^{mm} long. When disturbed they wriggled from the pod and fell to the ground, or bringing the two ends of the body together and suddenly straightening with a sudden jerk, they would jump to a distance of several inches.* The seeds themselves and the whole contents of the pod were in every case in a decaying condition. The larvae were of very different sizes, some apparently being nearly full grown, while others were evidently very young.

Some ten days after the pods had been placed in a breeding-jar, the adult flies began to appear—minute yellow midges with dusky wings. From that time on through the fall occasional examination of the pods showed larvae of all sizes still at work, many of the pods becoming entirely brown and dry before the middle of September. It was often a puzzling thing, in examining these pods, to find the points where the larvae made their exit, for the pupa state is passed under ground. Usually one, two, or three small orifices would be found, through which

*This habit is mentioned by Osten Sacken (Monogs. Dipt. I, 183) in the following words: "The larvae of several species, for instance, *Cec. loti*, *Cec. pisi*, and *Cecid. rumicis*, have the power of leaping. Mr. Loew remarks that all such larvae belong to the subgenus *Diplosis*. *Cec. populi* Duf. performed its leaps by straining the horny hooks at the tip of its abdomen against the under side of the thoracic segments." (Dufour, Ann. Sc. Nat., 2^{e} ser., XVI, p. 257.)

all the inhabitants of the pod must have issued. The manner in which this hole is made is a mystery. Examined from the inside, it shows marks of gnawings around its edge, and frequently spots are found where attempts to pierce the pod have evidently been made, but unsuccessfully. Yet as cecidomyid larvae have no horny masticating jaws, how have they then made these orifices? In pods which had evidently been attacked earlier in the season, while younger and tenderer, the holes were much larger and more abundant. Occasionally the pod will have become so dry that it will have cracked, and in such cases of course no other hole would be necessary.

DIPLOSIS CATALPAE, n. sp.

Larva.—Length, 3.25mm; greatest breadth (at middle of body), 0.7mm. Color varying from pale whitish to orange. Breast-bone, bright honey-yellow, .21mm long, and .06mm wide at the fork. Integument very smooth, transverse ridges barely perceptible, with a high power near the juncture of the segments. Sides of the body show the dividing line of the segments only as a slight notch, the junctures between the head and first thoracic segment and the eighth and ninth abdominal segments being most marked. Body apparently with 14 segments. Antennae apparently 4-jointed; first joint short and broad; second joint short, much narrower than joint 1; third joint three times as long as joint 2, but of same diameter; joint 4 a mere point at tip of 3, apparently the continuation of a tube which can be seen in joint 3. Stigmata very small, at the summit of almost imperceptible tubercles, the prothoracic tubercles and those upon the eighth abdominal segment being larger, more dorsal, and situated, the prothoracic at the front and the eighth abdominal at the hind border of its segment. The anal segment is very convex anteriorly, and almost truncate posteriorly, four or more small posterior projections being present.

Adult [male].—Length of body, 1.3mm; length of wing, 1.8mm; length of antenna, 2.5mm. Antennae, 26 (2 x 24) jointed; joints pedicelled, alternately single and double; single joints each with a whorl of long hairs; double joints with a whorl of delicate short hairs preceding the long one. Head slightly gibbous above, the eyes meeting upon the summit. Cross vein given off at one-half the length of the subcostal, not very oblique; 2d longitudinal vein nearly straight for three-fourths of its length, when it curves downward and reaches the margin of the wing somewhat beyond the apex; 3d longitudinal vein straight for one-half of the wing-length, when it forks, the branches forming a right angle first, which is, however, lost by the almost immediate downward bend of the upper branch. General color, light yellow; antennae fuscous, except basal joints, which are yellowish; legs somewhat shaded with fuscous, and furnished with quite long whitish hairs upon the femora; thorax above, with a long longitudinal dusky stripe on each side, also faintly dusky toward head; abdomen light yellow, with many short whitish hairs; balancers and claspers yellow, the latter dusky at tip; wings dusky, with a bluish iridescent appearance.

[Female.]—Length of body, 1.6mm; length of wing, 2.3mm; length of antenna, 1.3mm. Antennae 14-jointed (2 x 12); joints pedicelled, subcylindrical, and subequal, each joint with two whorls of short and delicate hairs, a whorl at each end of the joint, the hairs of the posterior whorl being somewhat longer than those of the anterior. Color as with the male, a little more dusky perhaps on the thorax. In other respects, except in generative organs, resembles the male.

Described from 4 ♂, 9 ♀ specimens.

THE RASPBERRY-LEAF ROLLER.

(*Exartema permundanum* Clem.)

Order LEPIDOPTERA; family TORTRICIDAE.

SYNONYMS.—*Exartema permundana* Clem. (1860); *Sciaphila meanderana* Walk. (1863); *Sericoris permundana* Clem. (1865); *Exartema permundanum* Zeller (1875).

Drawing together into a cluster the leaves at the end of raspberry stems and feeding within them, a small dark-green larva with pitchy-black head and thoracic plate, which transforms into a light-brown pupa, from which emerges a dull yellowish or greenish-brown moth.

On the first of June a considerable number of the larvae of a leaf-rolling Tortricid, which proved to belong to this species, was received from

Mr. F. S. Curtis, of Ithaca, N. Y., who stated that they were doing a great deal of damage to the foliage of the raspberry, especially at the end of the canes, often spinning all the leaves together in a more or less twisted mass, within which they fed. These larvae, when ready to transform, fold a part of a leaf either at the apex or base, partially cutting it away so that it hangs down, within which they change to a pupa. Generally the larva rolls up the leaf so that the whitish under side is out, thus making it more conspicuous.

The full-grown larva is about five-eighths of an inch in length, of a dark-green color, the head and thoracic plate being pitchy black. They are unusually active when disturbed, quickly letting themselves down from the rolled leaves by a fine silken thread. If, however, they are not further disturbed, they gradually draw themselves up again.

The pupa is of a light brown color, two-fifths of an inch long; covers of the hind wings with a rounded prominence at the base. Abdomen terminated by a three-pointed prominence with the usual minute hooks.

The moths have a wing expanse of half an inch. Fore wings dull yellowish or greenish brown, varying much in color, with irregular lighter markings crossing the wings obliquely. Hind wings ashy brown.

Distribution.—This species is reported from Maine, Massachusetts, New York, Pennsylvania, District of Columbia, Virginia, and Missouri.

Food plants.—Dr. Clemens first discovered this insect feeding on *Spiraea*, and Professor Fernald informs us that he has raised it at Orono, Me., on common meadow-sweet (*Spiraea salicifolia*) as well as on raspberry.

Remedies.—The terminal twigs containing the larvae and also the rolled leaves containing the pupae should be taken off and burned. Great care should be taken, however, lest the larvae escape when first disturbed.

THE ROSE-TWIG BORER.

Grapholitha Packardi? Zell.

Order LEPIDOPTERA; family TORTRICIDAE.

Boring into the twigs of rose and causing them to wilt and grow black, a small pinkish or rose colored larva with a brownish yellow head, transforming into a small grayish black moth.

In the early part of July, twigs of rose infested with a Tortricid borer were received from Mr. Henry Plumb, of Pleasanton, Kans. The larva appears to commence its work near the tip of a young shoot entering and eating its way upward for a short distance, till the portions above begin to wilt and die, when it works downward for about 2 inches, filling the cavity behind it with pellets of its excrement. The stem and leaves above its point of entrance become completely wilted and turn black, while the parts below remain more or less green.

The moths emerged July 20 and 22, and were referred to Professor Fernald for identification, who regarded the species as new.

These insects may be easily destroyed by cutting off the infested twigs and burning them before the moths emerge.

Larva.—Length 9^{mm}. Color straw-yellow, with minute granulations of scarlet over the upper surface, except on the tubercles and portions between the segments, giving the larva quite a pinkish look above. Head dark honey-yellow, with all the sutures brownish; antennae lighter; mandibles blackish at the tip. Thoracic plate light straw-yellow, highly transparent. Anal plate brownish behind, pink in front, and marked with round pale-brown spots.

THE ROLLER WORM.

(*Eudamus proteus* Linn.)

Order LEPIDOPTERA; family PAPILIONIDAE.

Rolling and eating the leaves of various garden vegetables in Florida, and presumably in other Southern States, a thick, cylindrical, yellowish-green worm, an inch and a half long, spotted with black, and with a narrow neck and a very large reddish head.

The larva and pupa of the variable *Eudamus* were first described by Smith and Abbot in 1797, the food plant being given as the wild-pea vine and also a wild leguminous plant, the name of which was not known. During the spring of 1880 I found that the garden crops in parts of Volusia County, Florida, were being quite seriously damaged by a worm which proved to be the larva of this butterfly. The crops principally injured by them seemed to be beans, turnips, and cabbage. Their method of work was for each to cut a slit into the leaf from the edge, and roll the flap thus formed around its body, working from the inside of this roll, with its soft parts perfectly protected. In the garden of the Brock House, Enterprise, almost every plant was badly ragged in this way. The full-grown larva is nearly 40^{mm} ($1\frac{1}{2}$ inches) long. In form it is somewhat cylindrical, swelling in the middle of the body. The neck is very slender and the head very large. The general color is yellow-green. There is a black line down the middle of the back, and many minute black spots on either side. There is a yellowish longitudinal stripe on each side of the middle, and low down on each side another whitish one. The first segment behind the head is horny and black in color. The head itself is also hard and black in color, with a broad reddish band extending from the top down nearly to the mouth on each side. This reddish band is nearly obsolete in the younger worms, and in the first and second ages is represented simply by two eye-like spots. Before transforming to a chrysalis the larva binds the leaf a little closer around itself and remains quiescent for a couple of days. The chrysalis is a little over three-quarters of an inch in length and is quite strongly bent backwards. It is light brown in color and is covered with a delicate bluish-white powder. The anal end is furnished with a spike-like projection, upon the summit of which may be seen, with a lens, a number of hook-form bristles. The duration of the chrysalis state, according to Smith and Abbot, is a little over a month, and our observations show this to be correct. The perfect insect is a handsome butterfly with a wing expanse of $1\frac{1}{2}$ inches. The hind wings are furnished with long tails, making the length of the two wings upon one side equal to the expanse of the two front wings. The general color is dark brown, the front wings containing several silvery-white spots, and the body and part of the hind wings having a greenish metallic luster. Their flight is not remarkably quick, and I have taken them in my hand while engaged in feeding on a plant. The eggs are laid in small clusters of from four to six each. They are quite large, measuring 1^{mm} (.04 inch) in diameter, light yellow in color, and with no discernible markings. The number of broods has not been ascertained, and indeed all notes from which this has been written have been fragmentary and the result of a very hurried examination.

No remedies seem to have been used; but I imagine that it would not be at all difficult to keep them in check by systematic hand-picking. The roll is always very distinct, and a single pinch of the thumb and

finger will suffice to kill the inclosed worm. If preferred, Dr. Fitch's plan of making use of a pair of shears can easily be adopted, a single clip to a roll being enough to incapacitate the worm for future damage.

THE CAULIFLOWER BOTIS.

(*Botis repetitalis* Grote [new species]).

Order Lepidoptera; family Pyralidae.

Feeding upon cauliflower, a pale, yellowish-brown larva, which transforms into a brown pupa, from which emerges a small, slender, brownish-yellow moth.

Specimens of the larva of this insect were received from Dr. A. Oemler, Savannah, Ga., who reported them as destructive to the cauliflower, and who also found them feeding on Ambrosia.

One lot of the specimens was received September 29, and another October 13. The full-grown larvae are about three-fourths of an inch long, pale yellowish brown, darker along the line of the back, the whole surface quite transparent and glassy in appearance, while the head is of a brownish color.

The specimens received from Dr. Oemler transformed and the moths emerged between the 14th of October and the 4th of November. They are quite slim, with an expanse of the wings of a little less than an inch, of a brownish-yellow color, with two irregular brownish lines across the wings, and two brown dots, one above the middle, the other nearer the base of the fore wings.

The pupa is of a light brown color, rather slim, about two-fifths of an inch long; anterior end rounded, posterior prolonged into a bill-shaped spine, which is armed at the end with several fine hooks. Abdomina segments without spines or punctures.

We append Professor Grote's description of the species:

Botis repetitalis Grote (new species):

Smaller and slenderer and with narrower wings than *feudalis*, but resembling that species in its color, being of a nearly uniform dusky or brownish ocher, with the disks a little paler; it is also more silky and subtransparent than its ally. It differs at once by the discal marks being both blackish and solid rounded dots, whereas in *feudalis* the reniform is elongate. The external margin is darker shaded and the abdomen is dotted on the sides of the two basal segments. The lines are much as in *feudalis*, accentuated on costa. This species is much like Guenée's figure of *detritalis*, but is differently colored, and in this varies from his description also. The body is white beneath. The wings are here paler, with the markings more faintly repeated. Length of fore wing, 11^{mm}. Georgia; two specimens in my collection; two specimens reared by Professor Comstock. The black dots on the abdomen are distinctive.

NOTES OF THE YEAR.

A Cecidomyid parasitic (?) upon a bark louse.—On September 13, 1880, at Los Angeles, Cal., while engaged in studying a bark louse on English walnut (*Aspidiotus juglans regius*), I was surprised to see a small dipterous insect emerging from its pupa skin, which was protruding from under the scale of one of the bark lice. Afterwards a larva was found under a scale of the same species, which evidently belonged with the fly.

Upon returning to Washington, it was discovered that the balsam in which the fly was mounted had filled the wing veins, and that the specimen was otherwise disorganized, so that a specific determination was impossible. Enough of the characters remained, however, to enable us

to place it in the genus *Diplosis*. Whether it was a true parasite or not, it is impossible to determine from the facts. Our purpose is simply to place it on record among the few other instances of parasitic or inquilinous *Cecidomyians*.*

EUGONIA SUBSIGNARIA IN GEORGIA.—During the past summer specimens of this common northern geometrid were received from Mr. Adam Davenport, of Morganton, Fannin County, Georgia. In the accompanying letter Mr. Davenport stated that the insects had first been noticed in the county two years before, and that they had rapidly spread until they were now destroying forests of hickory and chestnut and were doing much damage to the fruit trees. The principal damage done by these insects at the North has been to the shade trees in the large cities, notably New York and Philadelphia. In these localities there is but one brood in a year, the worms hatching in early spring and feeding upon the leaves until towards the end of June, when they spin up between the leaves. The moths issue in a week, pair, and lay their eggs upon the trunk and twigs of the tree, where they remain until the following spring. The worm is an inch and a half long and nearly black in color. The moth is pure white in color and has a wing expanse of an inch and a half.

As was evinced by reports received by Mr. Davenport, and by the fact that many of the eggs received were deposited upon *leaves*, there is evidently more than one brood each year in Georgia. The eggs were 1^{mm} long, half as wide, of a yellowish-brown color, and were placed upon end in small patches. As to remedies, it will prove a very difficult insect to fight in forests; but upon ornamental trees and shrubs and upon fruit trees it will not be difficult to destroy it. The former can easily be syringed with Paris green and water, from a garden syringe or fountain pump. With the latter it will be necessary to jar the trees in mid-day, or in warm sunshine, when the worms are most active. The shock will cause nearly all to drop, suspended by a silken thread; then by using a pole they can be brought to the ground and destroyed by crushing. In forests, however, I can see no means of getting rid of them, unless it should prove that the moths are readily attracted by light, in which case much good could be accomplished by building fires at intervals during the time of flight.

THE SNOWY TREE CRICKET (*Oecanthus niveus* Harr).—On account of the very frequent inquiries received at the department concerning this

* Of these instances we may mention the following: Walsh (Proc. Ent. Soc. Phil., VII, p. 228) states that the larva of *D. 7-maculata* lives in the galls of *Pemphigus vitifoliae* Fitch, and of *Cec. salicis brassicoides* Walsh. *D. aphidimysa* Rd., according to Rondani (Ann. Soc. Nat. Bolog., 1847, p. 443), lives under aphids, upon the leaves of *Persica, Cerasus, Sonchus* (*Siphonophora sonchi*), and *Rosa* (*Aphis rosae*), also upon *Aphis fabae*, upon beans. (See also Bull. Soc. Ent. It., 1877, I, 55.) The larvae of *Cecidomyia napi* are stated by Kaltenbach (Pflanzenfeinde, p. 34) to live under *Aphis brassicae*. Vallot (Mém. Acad. Dijon, 1826, p. 29) mentions *Cec. acarisuga*, the larva of which lives on the under side of the leaves of *Chelidomium majus* L., and feeds upon the mites which live there. Bergenstamm and Löw, however (Verh. d. Zool. Bot. Ges., in Wien, 1876, p. 93), consider that Vallot made a mistake in calling this larva a Cecidomyian. Osten-Sacken (Diptera of N. A., I, 179) says on this point: "Besides these, there is a class of larvae which live as guests, or parasites, in galls formed by other *Cecidomyidae* (*Cec. acrophila* Wz. and *pavida* Wz. live socially in the deformed buds of *Fraxinus excelsior*; *Dipl. socialis* Wz. inhabits the gall of *Lasioptera rubi*; *Dipl. tibialis* Wz. has been reared from the same gall with *Cec. salicina* Schr., &c.) or by *Acari* (*Cec. peregrina* Wz., and similar cases, observed by Löw). Some even live in the society of *Aphides*. According to Mr. Winnertz, the larvae of the subgenus *Diplosis* principally share these parasitical habits; even those living under the bark of trees or in fungi are seldom found alone, but for the most part in the society of other larvae (Winnertz Beitr. z. einer Monogr. d. Gall mücke. *Linnaea Entomologica*, *VIII*, 1853)."

well-known insect, it seems advisable to recapitulate briefly the main points in its life-history. Its eggs are deposited in the twigs of many trees and bushes. By economic writers, raspberry, blackberry, peach, apple, grape, cherry, hazel, sumach, and white willow have been mentioned. It is by the depositing of the eggs that the principal damage is done, as they are laid in a single irregular longitudinal row of deep punctures, by which the outer end of the twig or cane is killed. Upon splitting open a twig containing a row of these punctures, the eggs are to be seen lying diagonally across the pith. They are about 3^{mm} (0.11 inch) long, slender and somewhat curved, yellowish-white in color. The young crickets, which appear in May, are said to live principally upon plant-lice and eggs of other insects and even upon one another. As they grow older their diet tends to become more herbivorous and they feed upon the leaves or tender shoots of the plants they infest. When full grown they are of a delicate greenish-white color, the sexes differing considerably. The male is able by friction of the veins of his wings to make a chirping sound, which Dr. Fitch has likened to the word *treat, treat, treat*, repeated many times.

Upon one occasion in Western New York I witnessed a curious habit of this insect which I think has not been published. A male was observed standing upon a twig with his wings raised while a female behind him scratched him upon the back just behind the insertion of the wings, with her jaws. This was kept up for some time; and when the female, apparently becoming tired, moved away, she was recalled by a chirp. This occurred repeatedly, and whenever the female did not respond promptly the male made several quick and evidently impatient calls. Prof. J. E. Todd informs me that he has observed this habit also at Tabor, Ohio. It seems, therefore, that it is normal; but the explanation of it is not evident to us.

The damage done by the punctures of the female is frequently very considerable. Mr. Jacob L. Stryker, of Fredonia, Kans., writes us that all of his raspberries were killed to the ground. He also stated that the eggs were very abundant indeed in the common resin weed (*Silphium*). Mr. O. L. Williams, of Meadville, Pa., has also been much troubled by the punctures in twigs of peach and apple, the former being quite seriously damaged. Much damage is also frequently done in vineyards, unripe bunches of grapes being often severed at the stem.

The most effective remedy for the injuries of this insect will be found in searching for the punctured twigs during the winter and burning them. Where, as is the case in Kansas, the insects oviposit abundantly in a weed, it also should be carefully burned.

Although no parasite has ever been recorded as preying upon this insect, we have this year bred no less than four species of chalcids and proctotrupids, which time will not permit me to describe.

"BILL-BUGS" IN CORN.—About the 1st of June, two species of *Sphenophorus* were received at the department. The one, *S. pertinax*, was sent by Mr. S. M. Robertson, of Dadeville, Tallapoosa County, Alabama, and the other, *S. sculptilis*, by Mr. E. T. Stackhouse, of Marion Court-House, S. C. Both were represented as injuring young corn extensively, the former piercing the stalk just below the surface of the ground, and the latter at or just above the surface. Mr. Stackhouse stated that they had attracted but little attention in his vicinity until within the last two or three years, but that they now threatened the destruction of the entire crop in many sections of Marion County. A later letter from Mr. Robertson (February 6, 1881) states that he found the ravages of *pertinax* were confined to low, flat lands. On the Tallapoosa River bot-

toms which he planted they were very destructive, killing the corn as late as August, while on the land adjacent there was no sign of their work.

A "bill-bug" was spoken of by Glover in the department report for 1854 as "*Sphenophorus*"? the habits of which were similar to the species mentioned above. This insect was stated to have undergone its transformation within the stalk, the beetles laying eggs at the roots, and the grubs hatching and feeding upon the stalk and transforming within it to pupae, the adult beetles appearing again in spring. We have no information whatsoever concerning the transformations of *S. pertinax* and *S. sculptilis*. Mr. Glover mentions the occurrence of his species on the Pedee River in South Carolina, in Alabama, and on the Red River in Arkansas, and states also that swamps and low lands are the places most generally attacked.

As to remedies, Mr. Robertson tried quicklime, salt, ashes, land plaster, and guano successively around the roots of corn to drive the beetles away, but entirely without effect. An examination of the old stalks during the winter showed that fully 50 per cent. of them contained the beetle in the tap root, alive, in spite of the extreme severity of the winter. In a five-acre bottom that remained under water for six days in January on account of an overflow, they were found as plentiful and as healthy as above high-water. Their presence in the stalks, however, naturally suggests the burning of stalks and stubble during the winter in order to destroy the insects. This course was followed in former years, according to Mr. Glover, with the effectof very perceptibly diminishing the numbers of the *Sphenophorus*.

THE RICE WEEVIL (*Calandra oryzae* Linn.)—In consideration of the extreme destructiveness of this beetle in all of its stages to stored grain, especially in the South, the mention of the fact that a parasite has been discovered which destroys it will be of interest. In the latter part of February specimens were received from Mr. P. S. Clarke, Hempstead, Waller County, Texas, with complaints of great injury to stored corn in his vicinity. The specimens received were contained in two ears of corn, which were placed in a breeding-jar in order to note the length of time which the insect remained in its different stages and other points. On August 10 two chalcids were observed in the jar, and had it not been for an accident by which the weevils were all destroyed, doubtless more could have been bred. These parasites were very small and steel-blue in color, with large red eyes. They were determined by Mr. Howard to be a new species of the genus *Pteromalus*. His description follows:

PTEROMALUS CALANDRAE Howard (n. sp.):

Length of body, 1.15mm. Expanse of wings, 1.65mm. Width of fore wing, 0.36mm. Head large, somewhat broader than thorax. Antennal subclavate, somewhat pilose, as long as thorax; joint 5 small, equal in length to the two ring joints; thorax nearly as broad as long; almost no indications of parapsidal furrows. Abdomen cordate, sessile, stout. Head, face, and dorsum of thorax finely punctured, with many fine white hairs. Abdomen smooth and shining. Color: Head and thorax steel-blue; abdomen yellow-brown at base, black and shining at tip; antennal scape fuscous, flagellum nearly black; all femora dark brown; tibiae lighter; tarsi nearly white, last joint darker; wing veins yellow-brown. Stigmal vein as long as marginal, and one-half as long as submarginal.

Described from 1 ♂ specimen bred from the pupa of *Calandra oryzae* Linn.

The same parasite was bred from specimens of another beetle injurious to stored grain—*Sitodrepa panicea*—and it is probably the one mentioned by Packard (Guide to the Study of Insects, p. 470) as parasitic upon this same beetle, which occurred in great numbers in the nests of wasps in the museum of the Peabody Academy at Salem.

INSECT ENEMIES TO SUNFLOWER.—With the increasing value of the sunflower as a crop, naturally the importance of its insect foes increases. About the middle of August specimens of a beetle closely allied to the sugar-cane beetle of Louisiana, and known as *Ligyrus gibbosus*, were received from Mr. Sterling L. Parker, of Saint James, Nebr. Mr. Parker had found them at the roots of plants of a sickly appearance, from five to twenty-five of the beetles to each plant. They had eaten the bark from the root and scored long grooves into the wood. The white larvae were also found in the same situation, doing apparently the same work. The bugs themselves have a strong resemblance to the common May beetles, but were considerably smaller and of a somewhat darker color. Mr. Parker, at the time of writing, had tried salt and ashes around the roots of the plants, but with no success in driving the bettles away. We should advise experiments with air-slaked lime around the roots, as that substance has been found efficacious with allied insects working similarly.

Mr. G. M. Dodge, of Glencoe, Dodge County, Nebraska, wrote late in the fall, stating that a species of *Ligyrus* was sometimes very abundant in his locality, and often nearly exterminates the wild sunflower by working at its roots. He had also observed it upon the cultivated sunflowers and dahlias. He surmised the species to be *Tridentata*, but it has since proven to be the same as those sent by Mr. Parker.*

According to Mr. S. S. Hargraves, of Pearson, Coffee County, Georgia, there was a beetle which occurred in considerable numbers in his locality during the season, and which injured the sunflower by devouring the leaves and the "bloom of the flower," and also by "sucking the sap from the seed." The receipt of specimens proved the beetle to be a new species of the genus *Luperus*, and it has been transmitted to Dr. Horn for description.

REMARKABLE FLIGHT OF ZERENE CATENARIA GUENÉE.—An associated press dispatch reading as follows appeared in the papers of October —, 1880, Lackawaxen, Pa.: "Immense numbers of large white butterflies have made their appearance, to the alarm of the farmers. The mass is so dense in some places that it appears like a snow-storm. Their destruction would probably avert the ravages of the army worm." Through the kindness of Mr. C. W. Shannon, postmaster at Lackawaxen, specimens of this so-called butterfly were received at the department. They proved to be the quite common geometrid moths known scientifically as *Zerene catenaria* Guenée. The geographical range of the species is large, being found from Maine to Colorado. The larvae is one of the "measuring worms," is yellow in color, and, when full grown, measures an inch and a half in length. The alarm caused by the unusual swarming of the moths was entirely uncalled for, since the larva has never been known to attack a cultivated crop. The only food-plants known so far are the wild indigo (*Baptisia tinctoria?*), wood wax (?), wild blackberry, and several of the sedges, notably *Carex pennsylvanica*.

WINE-CASK BORERS.—Complaints were received during the summer from Mr. S. J. Matthews, of Monticello, Ark., of the damage done to his wine casks by beetles which bored through and let the wine drip out. Specimens of a small scolytid beetle known as *Monarthrum fasciatum* Say accompanied the letter. According to Mr. Matthews statement,

* It is here worthy of remark that this same beetle, *Ligyrus gibbosus* De Jean, was received in the grub state early in the summer from Mr. David Donaldson, of Locke Hill, Bexar County, Texas, who reported them as quite injurious to his crop of potatoes.

the beetle worked mostly in the chines and joinings and under the edges of the hoops, but occasionally in the middle of the heads or staves. Formerly it had been easy to keep them in check by painting the casks with white-lead and oil; but latterly they hardly waited for the paint to dry before commencing their attacks, causing the double loss of casks and wine. Many of these little wood-boring beetles have long been known to cause similar injuries. In India *Tomicus monographus* is stated by Morse to do great damage by drilling holes in malt-liquor casks, the custom being to destroy the beetles by submerging the casks in boiling water. In California *Sinoxylon declive* Lec. has similar habits. Oak, chestnut, pine, whitewood, and eucalyptus wood have all been used in making casks with a view to discovering some substance which would prove distasteful to the beetles, but without success. Dr. Rivers, curator to the Museum of the University of California, has, however, succeeded in making a cask apparently beetle-proof by saturating the outside with a strong solution of alum water applied while hot, and, as soon as dry, painting with linseed oil. The cask thus treated remained unharmed by the beetles while others were riddled.

EUPLECTRUS COMSTOCKII HOWARD.—The parasite of the cotton-worm figured on page 196 of the Report on Cotton Insects, under the head of "The unnamed Chalcid parasite," has been described by Mr. Howard under the above name (Canadian Entomologist, XII, 159).

Mr. E. A. Schwarz, in a very interesting article, has recently cleared up all the doubtful points in the life-history of this insect (American Naturalist, January, 1881, p. 61). The eggs of the *Euplectrus* are laid in groups of from one to fifteen upon young cotton-worms usually less than one-third grown. The larvae, hatching, feed externally, never moving from the spot when hatched, and attain their full growth in from three to four days. The cocoon (improperly so called) is simply a web or mesh of coarse yellowish white silk by which the empty skin of the cotton-worm is attached to the leaf. Within this mesh, and between the caterpillar skin and the leaf, the *Euplectrus* larvae transform to pupae, in which state they remain from three to eight days. At Selma, Ala., the almost complete destruction of the worms in early October, 1880, was principally due to this parasite.

A smaller species of *Euplectrus* was bred at the department last spring, from a small Bombycid larva found on black gum at Fort George, Fla., by Dr. R. S. Turner. Its cocoon was precisely similar to that of *E. comstockii*, and its habits are probably the same.

The figure of *E. comstockii* which was given in the report on cotton insects, from want of good material, is very incorrect. We therefore publish in this report (Plate II, Fig. 2,) a corrected figure of the species.

DATES OF PUBLICATION OF ENTOMOLOGICAL REPORTS.

As the entomological reports recently published by this department contain diagnoses of many species of insects new to science, it is important that the exact dates of publication of these reports should be known.

REPORT UPON COTTON INSECTS, 1879.—This report was published May 18, 1880, by the distribution of copies to each member of Congress.

REPORT OF THE ENTOMOLOGIST FOR 1879.—This report was published October 18, 1880, by the distribution of 130 copies of an author's edition to entomologists.

REPORT ON INSECTS INJURIOUS TO SUGAR CANE. (Special report No. 35).—Published April 28, 1881.

PART II.

REPORT ON SCALE INSECTS.

INCLUDING DESCRIPTIONS OF COCCIDAE IN THE COLLECTION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE, WITH NOTES UPON THE HABITS OF THOSE INJURIOUS TO CULTIVATED PLANTS, AND THE RESULTS OF EXPERIMENTS IN THEIR DESTRUCTION.

INTRODUCTION.

There is no group of insects which is of greater interest to horticulturists to-day than that family which includes the creatures popularly known as "scale insects" and "mealy bugs." There is hardly any shrub or tree but that is subject to their attack; and in certain localities extensive orchards have been ruined by them. The minute size of the creatures, the difficulty of destroying them, and their wonderful reproductive powers, all combine to make them the most formidable of the pests of our orchards and ornamental grounds. It is only necessary to cite the mealy bugs of green-houses, the oyster-shell bark-louse of the apple, and the various species of scale insects destructive to citrus fruits to establish this fact.

Notwithstanding the great importance of the subject, comparatively little thorough work has been done on the species of this country. This is doubtless in a great part due to the difficulties attending a careful study of even a single species of this group, and the fact that the small size and plain appearance of the insects render them unattractive to most entomologists.*

This report on scale insects is an outgrowth of the investigation of insects injurious to orange trees, which was begun last year. In the early part of that investigation I became convinced that by far the greater part of the injury done to orange trees by insects was caused by scale insects; and that I could not do a more useful work than to make an exhaustive study of that family, including not merely those that infest citrus trees, but all the species occurring in the United States. I collected many of our southern species while on a trip through the State of Florida during the months of January and February, 1880; during the following summer I spent three months in the fruit-growing sections of California and Utah, investigating the scale insects found there; and extensive collections were also made by assistants and correspondents in the eastern part of the United States. A series of experiments were made to ascertain the best method of destroying these pests, and with very satisfactory results. These experiments will be continued during the present season. Many species, including all those that infest oranges in this country, were colonized on small trees growing in pots in the breeding room of the division. In this way we have been able to follow their complete life history. In some instances the species has been observed daily through five generations.

For want of time I have been unable to prepare descriptions of all the species which we have collected. I hope, however, to be permitted at some future time to publish a more exhaustive memoir on the subject, and trust that the reader will remember that this is simply the result

* Previous to this only about thirty species have been described by American writers; and of this number more than one-half were described by Dr. Asa Fitch, the first State entomologist of New York.

of but little more than one year's study pursued with limited means (there being no special appropriation for it) and in addition to the ordinary duties of the division of entomology.

CHARACTERS OF THE COCCIDAE.

The scale insects or bark-lice, and the mealy bugs, together with other insects for which there are no popular names, comprise the family known to entomologists as the coccidae. This is a division of the order HOMOPTERA, to which belong also the plant-lice (*aphidae*), the cicadas, the leaf-hoppers, and certain other insects.

We will not in this place enter into a discussion of the characters of he homoptera or of the zoological relations of the coccidae to the other families included in that order. But referring those who are interested in these points to the text-books on entomology (see also report of this department for 1876, pp. 24–46), we will proceed at once to a discussion of the coccidae.

In many respects this is a very anomalous group of insects, differing greatly even from closely allied forms in appearance, habits, and metamorphoses. Not only do the members of this family appear very different from other insects, but there is a wonderful variety of forms within the family; and even the two sexes of the same species in the adult state differ as much in appearance as insects belonging to different orders.

The most obvious characters in which the coccidae agree, and by which they may be distinguished from other insects belonging to the homoptera, are the following: the females never possess wings; the males are winged in the adult state; but unlike other homopterous insects possess only a single pair of wings, the second pair being represented by a pair of small club-like organs called halteres, each usually furnished with a bristle, which in all the species that I have studied is hooked and fits into a pocket on the anterior wing of the same side*. (See plate XXI.) The male in the adult state has no organs for procuring food, the mouth parts disappearing during the metamorphoses of the insect and a second pair of eyes appearing in their place.

The strange forms assumed by certain species of bark-lice has led to their being mistaken for very different organisms. Thus the adult females of a species of a genus of bark-lice (Kermes) common on oaks in various parts of the world have been commonly mistaken for galls. A species of this genus is represented on plate IX, fig. 1; the gall-like objects on the twig of oak are the females; the immatured males are very different in form, and are represented on the leaves. The resemblance to galls is shared somewhat by certain other genera of this family. In fact, the family is termed by the French *Gallinsectes* on account of this resemblance.

There is a remarkable species belonging to this family found in the West Indies in the furrows of the land newly turned up, which from its resemblance to a pearl is known as the ground pearl, and is frequently sent to Europe in collections of shells under that name. It is stated by Guilding, who first described this insect (Trans. Linn. Soc. Lond., 1833, T. 16, P. 1, pp. 115–119) under the name of *Margarodes formicarium*,

*The relations existing between the halteres and the anterior wings were first observed by Mrs. Comstock while making drawings for this report. She has repeatedly seen a male in the act of replacing the hook of the bristle in the pocket from which it had been removed while the insect was being mounted for examination under a microscope. Our observations, however, have been too limited to enable us to state positively what is the function of the halteres; but we believe that they aid in flight.

that it occurs in the Bahamas, and is strung into necklaces and ornamental purses by the ladies. It was believed by Guilding that the ground pearls were parasitic on the ants, in and near the nests of which they were found. I think, however, that it is more probable that the so-called pearls derive their nourishment from the roots of plants in the soil, and that they, instead of destroying ants, furnish them with food in the form of an excretion, as many other species of Coccidae are known to do.

The habit of excreting a sweet fluid, which many species possess, together with the strange forms of the insects, has also led to some strange mistakes. Thus one species which occurs on pine was at first taken for a nectar-secreting gland (Unger, Flora, 1844, p. 713).

DIVISION OF THE COCCIDAE INTO SUBFAMILIES.

Owing to the great diversity of form and structure among the species belonging to this family they may be grouped into several subfamilies; and such a grouping is necessary before generalizations can be made respecting the habits and metamorphoses of the various species. Signoret in his monograph of this family divides it into four sections.* We believe that each of these sections should rank as a subfamily, and will so consider them. They are characterized as follows:

I. DIASPINAE.—This subfamily includes all the species of Coccidae covered by a scale composed in part of molted skins and partly of a secretion of the insect.

Examples.—The oyster-shell bark-louse of the apple (*Mytilaspis pomorum*), the red scale of the orange (*Aspidiotus aurantii*), and Glover's orange scale (*Mytilaspis Gloverii*).

II. BRACHYSCELINAE.—This subfamily includes certain species of Coccidae which live in galls. All the described species are Australian. Consequently the subfamily will not receive further notice in this report.

III. LECANINAE.—The original characters of this subfamily as given by Signoret are as follows: Species either naked or inclosed, or simply covered with waxy calcareous or filamentary material; most of the females after impregnation taking on a different form, and, once fixed, remaining so for the rest of their lives, although while young they retain the power of moving under certain circumstances.

IV. COCCINAE.—Signoret originally gave the characters of the Coccinae as follows: Females keeping the form of the body with the segments distinct until the end, and also retaining the power of motion; they are naked or covered more or less with a wavy whitish excretion, filamentary and more or less spumous.

These characters were afterwards found to be insufficient to separate the two groups as the genus *Kermes* which, from the study of the young larva, belongs evidently to the Coccinae, is fixed and covered with a hard horny substance, hiding the segmentation and giving it precisely the appearance of a Lecanium. Signoret therefore substituted the following characters: Lower lip 1-jointed in the Lecaninae, multiarticulate in the Coccinae; anal plates present in the Lecaninae, absent in the Coccinae; anal extremity with the Coccinae divided into two lobes, each furnished with a long bristle.

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* Annales de la Société Entomologique de France, 1869, p. 98. We have not included the section *Lecanodiaspis* established by Targioni Tozzetti, as all the representatives of it which we have been able to study have been found to belong to some one of the other sections.

Examples of Lecaninae.—The black scale of California (*Lecanium oleae* Bernard), the maple-bark louse (*Pulvinaria innumerabilis* Rathvon), the lac insect (*Carteria lacca* Ker.).

Examples of Coccinae.—The mealy bugs (*Dactylopius*), the cochenille insect (*Coccus cacti* Linn.).

METAMORPHOSES OF THE COCCIDAE.

The changes through which a scale insect passes in the course of its development are very remarkable. But as the metamorphoses and habits of each division of the family are somewhat peculiar, it is necessary to consider each subfamily by itself. We will discuss in this place only the first sub-family.

1. THE DIASPINAE.—The newly-hatched scale insect is oval in outline, much flattened, furnished with six legs, a pair of antennae, and an apparatus for sucking the juices from plants. (See Plate III, fig. 2*c*, young of *Aspidiotus ficus*.) At this stage of its existence it is very small, a mere speck, which the untrained eye could only with difficulty detect. By means of a lens, however, these minute creatures can be seen crawling in all directions over the leaves or bark of an infested tree. After wandering for a time, usually but a few hours or even less, the young scale insect settles on some part of the plant, inserts its beak, and, drawing its nourishment from the plant, begins its growth at the expense of its host. In a short time there begins to exude from the body of the larva fine threads of wax, which are cottony in appearance. The excretion of this wax continues until the insect is completely covered by it. The rate at which this excretion is produced varies greatly. Thus larvae of the red scale of Florida (*Aspidiotus ficus*) which were only one day old were found to be completely covered by the cottony mass which they had excreted, while the larvae of Glover's scale (*Mytilaspis Gloverii*) did not become entirely covered until they were six days old. Sooner or later the larva begins to excrete a pellicle, which, although very thin, is dense and firm in texture. The mass of cottony fibers either melts or is blown away, or, as in certain species of aspidiotus, a portion remains as a white dot or ring on the center of the scale. After a period, which in several species that we have studied is about one-half of the time from the hatching of the larva to the emerging of the male, or one-third of the time from the birth of the female to the date at which she begins ovipositing, the larva sheds its skin. In some species this does not take place until after the beginning of the formation of the permanent scale, and in such cases the molted skin adheres to the inner surface of the scale, and cannot be seen while it is in its normal position on the plant. This is true of many species belonging to the genus Aspidiotus (*A. ficus*, *A. citri*, *A. perniciosus*, and others).* In these species the position of the exuviae is indicated by a nipple-like prominence, often marked by a white ring or dot, which is the remains of the cottony mass first excreted. In other species the molt takes place before the beginning of the excretion of the permanent scale. In these the larval skin is plainly visible either upon the surface of the scale, as in certain species of Aspidiotus (*A. nerii*, plate IV, fig. 1*c*) and in Diaspis (plate V, fig. 1*a*, 2*a*), or at one extremity, as in Mytilaspis (plate VII, fig. 1*a*). Sometimes, however, the larval skin is covered by a delicate transparent layer, which, I think, is the melted or compacted remains of the cottony mass excreted by the young larva (plate VII, fig. 2*a*).

* For figures of *A. ficus* and *A. citri* see Plate III.

The change which the larva undergoes at this molt is a very remarkable one, appearing to be a retrogression instead of an advancement to a more highly organized form, as is the rule in the development of animals. With the skin are shed the legs and antennae.* The young scale insect thus becomes a degraded grub-like creature with no organs of locomotion. The mouth parts remain, however, in a highly developed state and are well fitted to perform their functions. This apparatus is not the least remarkable thing in the structure of these insects. It is terminated by a thread-like organ, which is frequently much longer than the body of the insect, and is composed of four delicate hair-like bristles. By means of this organ the insect is firmly attached to the plant and draws its nourishment therefrom. From this stage the development of the sexes differs.

The second and last molt of the female takes place, in those species which we have studied most carefully, when she is about twice as old as when the first molt occurred. The change in appearance at this molt presents nothing remarkable. The second cast skin is joined to the first and with it forms a part of the scale which covers the body of the insect. Sometimes, as in the genus Fiorinia (plate XX, fig. 4), this molted skin is very large and constitutes the greater part of the scale; but more commonly the exuviae form but a small proportion of the scale, the greater part of it being excreted subsequently to the second molt. Soon after the second molt of the females takes place the adult males emerge, and doubtless the impregnation of the females occurs at once. After this the body of the female increases in size, becoming distended with eggs. The oviposition takes place gradually, and in those species that we have studied begins when the female is about three times as old as when the first molt occurred. In other words, the three intervals between the birth of the female and the first molt, between the latter and the second molt, and between this and the beginning of oviposition are about equal. The eggs are deposited beneath the scale, the body of the female gradually shrinking and thus making room for them. (See plate VII, fig. 1*b* and 2*c*.) Some species, however, are viviparous.

The male scale insect during the early part of its larval life is indistinguishable from the female. The first molt occurs at the same time and is accompanied by a similar change, the male larva like the female losing its legs and antennae. The second molt is also synchronous with the second molt of the female; but here the similarity in form between the two sexes ceases. Even before this molt takes place there may be observed the formation of rudimentary limbs beneath the transparent memberless skin of the larva; and after this skin is shed the male, now in the pupa state, differs remarkably from the female. The male pupa has long antennae, and its legs and wings, although in a rudimentary state, are very large. The duration of the pupa state in those species which we have bred is short, lasting but a few days; and then after a third casting of the skin the adult male appears.

The outline figures on plates XXI and XXII represent the insect in this stage. The anterior wings, though very delicate, are large, and enable the male to fly readily. The posterior wings are represented only by a pair of halteres. These insects resemble in this respect the flies, gnats, and other insects belonging to the order diptera, or two-winged insects. The posterior end of the body is furnished with a style which is sometimes nearly as long as the remainder of the body, and is the external

* Rudiments of antennae are sometimes retained, as in certain species of *Mytilaspis*.

organ of reproduction. As our figures represent only a dorsal view, the most remarkable character of the adult, the supplementary eyes which take the place of the mouth parts, is not shown.

EXPLANATION OF CHARACTERS USED IN CLASSIFICATION OF THE COCCIDAE.

Many members of this family differ so greatly from the ordinary forms of insects that in classifying them it becomes necessary to use characters peculiar to them. This is especially true of the subfamily Diaspinae, where the scale and the last segment of the female present nearly all of the tangible specific characters. Much stress has been laid by certain writers upon the characters presented by the male. But, although we have done our best, we have found little in this sex that is of value for separating closely allied species that can be put into words. We have bred the males in much greater numbers both of species and of specimens than has ever been done before by a single student. These have been figured very carefully, the drawings being made on a large scale and reduced by photography. Great care has been taken to represent accurately the shape and relative size of the different parts of the body. The results of our labor in this direction are given with the hope that in the future they may be found of more value than appears to us now. The disappointment which we have experienced in the study of the males has been relieved by the success which has attended our study of the margin of the last segment of the females of the Diaspinae. Here we have found a set of characters which have received almost no attention heretofore, but which are almost the only ones which can be relied upon for separating closely allied forms.*

SCALE.—The term *scale* is applied to the thin pellicle which covers the dorsal surface of the bodies of all the Diaspinae. It is composed in part of molted skins, of which *two* are attached to the scale of the female, and *one* to that of the female; these are termed the *exuviae*. There is also a layer composed of excretion, and, in some cases at least, of the ventral half of the molted skins between the body of the insect and the bark of the plant upon which it is. This layer varies greatly in thickness and presents in some instances specific characters. I do not find that it has been noticed by authors. In the descriptions of species I have termed it the *ventral scale*.

LAST ABDOMINAL SEGMENT.—As stated under the head of *Metamorphoses*, the members of the subfamily Diaspinae undergo a remarkable change at the time of the first molt, losing their legs and antennae, and thus becoming apparently less highly organized than in the larval state. At the same time the last abdominal segment assumes a remarkable form, becoming flattened and fringed with numerous appendages. In the male this character is transient; the form of this segment changing gradually, previous to the second molt, to that which it bears in the

*Although I have endeavored to so describe and figure the more important species of scale insects that they may be easily recognized by any careful reader, still I am forced to state that in many cases it is useless to try to separate closely allied species by a study of the scale alone. The most reliable characters are presented by the spinnerets, and the fringing lobes, plates, and spines of the caudal segment of the adult female. In the study of these characters good work can only be done with the best of apparatus. The specimens must be carefully mounted and examined with a good microscope using a one-fifth inch objective or a higher one. We have used for our finest work a Hartnack No. 9 (equivalent to one-eleventh inch Am. objective) and a No. 5 eye piece; this combination gives a magnification of about thirteen hundred diameters.

pupa state. In the female, however, this segment becomes hardened apparently by the deposition of chitine, and the peculiar form is preserved throughout the remainder of the insect's life. In fact, so completely are these parts chitnized that their peculiar forms are preserved even after the insect is dead and the remainder of its body is so shrivelled as to be unrecognizable.*

The very careful study which we have made of this segment and its appendages, embracing an examination of several thousand mounted specimens, has demonstrated that the characters here presented are very constant within the limits of each of the species which we have investigated. In fact they are the only characters upon which we have been able to place implicit confidence in separating closely allied forms. I have therefore given considerable space in the description of species to these characters. In each case the description has been based upon a study of the adult female.

Upon the dorsal surface of the segment are usually several lines of holes which are the openings of glands which excrete a part at least of the substance of which the scale is composed. I have studied specimens in which there was a thread of excretion extending from each of these openings to the scale. Although these openings are very prominent I have failed to find that they present specific characters, and so have made no use of them in classification; and have figured them in but few instances. In the more transparent species they are easily seen through the body when examining it from the ventral side, and unless a good microscope be used, the openings of the two surfaces will be confused. Near the center of the ventral surface of this segment is the *vaginal opening*, which is large, and which is represented in nearly all of our drawings of this segment.

In most species there is a greater or less number of peculiar openings arranged in groups around the vaginal orifice. These are termed *Spinnerets* (*filières*) by Signoret, a term which is also applied to various other openings, tubes, and tubular spines which occur on this and other segments of the body, and which are supposed to be openings to glands which excrete the covering of these insects. The pores which are arranged in groups about the vaginal opening differ remarkably from others in being compound, each spinneret being a circular plate perforated by several small openings.†

The presence or absence of these spinnerets, the number of them in each group, and the number of groups, are characters of some value in classification. They cannot however be relied upon implicitly. The number of spinnerets in each group varies more or less in every species, and even upon the two sides of the body of the same individual. But as this variation is usually quite limited it does not render this character valueless. In most species the number of the groups of these spinnerets is either four or five. When they are five, one is situated cephalad of the vaginal opening, and two on each side of it. These groups I have designated as the anterior, anterior-lateral and posterior-lateral respectively. When there are only four groups, it is the anterior one that is wanting. Other forms of grouping of the spinnerets exist and will be described in the descriptions of the species in which they occur. On the posterior margin of the segment are situated numerous

* In one instance I removed from under their scales the dried bodies of scale insects which had been in a collection for twenty-five years, and found that the characters presented by this segment were perfectly preserved.

† I have observed similar compound spinnerets near the base of the oral setae in several species (*C. furfurus* and *P. Pergandii*).

appendages of which three forms may be distinguished; these I have termed lobes, spines, and plates.

The *lobes* are usually the most conspicuous of the appendages of this segment. They appear to be inserted in a groove between the posterior edges of the upper and lower surfaces of this segment. But in two species which I have succeeded in dissecting (*A. obscurus* and an undescribed species) I found each lobe to consist of a prolongation of the margins of the dorsal and of the ventral walls of the segment; these prolongations being much thickened and joined at their distal extremities. This thickening of the body wall extends anteriorly for a short distance upon both the dorsal and ventral sides of the body, but chiefly upon the former. The number of these lobes varies from one to four pairs.

In some species a part of the *lateral margin* of the segment appears to be of the same structure as the lobes.

In certain species *thickenings* of the body wall occur near the prolongations of the lobes but more or less distinct from them. In each of the species which I have dissected these thickenings are on the dorsal side of the body; this point can be determined only by splitting the specimen and studying the dorsal and ventral halves of the body separately. In an unmutilated specimen the thickenings of the body wall appear like organs within the body. The number, size, and position of these thickenings afford good specific characters.

In certain species the posterior margin of the segment is incised two or three times (usually twice) on each side of the meson. These *incisions* and the edges of them (which are usually thickened) afford characters of importance. As with the thickenings described above it is difficult to determine from an unmutilated specimen upon which surface these incisions are. They are represented in all of our drawings as they appear when seen from the ventral side.

The *spines* are situated near the posterior margin of the segment. There are usually two, one on the dorsal surface and one on the ventral surface, associated with each of the lobes. Others are situated at various intervals between the lobes and the penultimate segment. In many instances these spines appear to be tubular; and I have repeatedly seen what appeared to be threads extending from them; hence they may be spinnerets.

In the descriptions the lobes and spines are numbered, beginning at the meson, the corresponding lobes of each side of the body bearing the same numbers. They are thus considered in pairs; as are the legs and wings of other insects, excepting that in numbering the lobes and spines the numbers increase cephalad instead of caudad.

Under the head of *plates* I have classed all the remaining appendages which fringe this segment. They are usually long, flattened, and more or less notched or toothed. Sometimes, however, they are hair like or spine like. This is especially the case on the side of the segment; here, too, the form and number are not so constant as it is between the lobes. When studying the ventral surface of this segment a clear spot on the middle line of the body is usually visible. This is the *anal opening;* and is really on the dorsal surface of the segment; its apparent position is represented in the figures, and as will be readily seen varies greatly in different species.

There are many other openings and appendages of this segment which we have not represented in our figures, as no use has been made of them in classification, and the representation of them would only tend to confuse the illustrations.

TERMS DENOTING POSITION OR DIRECTION OF ORGANS.

The use of the terms upper, lower, inner, outer, before, behind, and similar expressions in the technical descriptions of animals, or of their parts, has led to so much confusion that there is a strong movement on the part of the leading zoologists in favor of a more exact anatomical nomenclature.* Although many of the terms proposed may never be adopted, others which are obviously appropriate, definite, and concise are rapidly coming into use. A few terms of this class are introduced into this report. The position and direction of all parts and organs are referred to an imaginary plane dividing the body into approximately equal right and left halves. This middle plane or any line contained therein is designated as the *meson*. The corresponding adjective is *mesal*, and the adverb *mesad*. In combination meson becomes *meso*. The well known adjectives *dorsal*, *ventral*, *dextral*, *sinistral*, *lateral*, *proximal*, *distal*, *cephalic*, and *caudal* are used in preference to less definite terms, as are also the corresponding but less familiar adverbial forms, *dorsad*, *ventrad*, &c.

METHODS OF PREVENTING THE SPREAD OF SCALE INSECTS.

The facts given above suggest the following methods of preventing the spread of scale insects to orchards and other cultivated grounds not already infested by them. In planting an orchard, choose as isolated a spot as practicable, so as to be able to control as fully as possible the conditions upon which the introduction of pests depends. If isolation cannot be obtained, an effort should be made to induce the owners of neighboring orchards to join in the determination to grow clean fruit. The greatest care should be used in the purchase of trees and in the importation of buds. Before planting, thoroughly wash all such trees with some substance, as a strong solution of soap, which will destroy insects without injury to the trees; buds and scions brought from other orchards should be treated in the same way before using. The fact that trees or scions appear free from pests should not deter one from using the utmost precaution, for the untrained eye would fail to detect the early stages of these insects. Do not visit infested orchards unnecessarily; and, above all things, do not carry home specimens of scale insects as curiosities. The trees should be watched carefully, and if one is ever found to be infested with scale insects it should be destroyed at once. Remember that no better investment can be made than to burn such a tree, and that no other time is so good for doing it as the day it is first found to be infested. The system of exchange of fruit boxes which is practiced in some markets, notably in San Francisco, is a very dangerous one. Each shipper should have his boxes marked, and insist on not receiving boxes belonging to other shippers. And in any case when boxes are sent to a market where fruit from infested orchards is received they should be scalded on their return. This precaution will tend to check the spread of the coddling moth and other pests as well as scale insects.

The use of fertilizers is often recommended as both a preventive of the attacks of scale insects and a remedy to be used when an orchard becomes infested. The general testimony of fruit growers is that sickly trees are much more liable to be attacked by scale insects than those which are healthy. Doubtless, in many in instances, the effect of the

*See paper by Dr Burt G. Wilder on "A Partial Revision of Anatomical Nomenclature." Science, vol. ii, pp. 122-133.

presence of insects has been considered the cause; but in other cases, some of which have come under my observation, the sickly condition of the tree has certainly preceded the attacks of the insects. It is difficult to explain these phenomena, unless we suppose that the sap of a sickly tree is in some way more nutritious than that of a vigorous tree, for the period during which these insects can travel is so limited that they are not able to make a choice of food plant, but must, under ordinary circumstances, live or die on the plant upon which they were born. Let the explanation be what it may, the fact remains that vigorous trees are less liable to become infested by scale insects. I have also been assured by many fruit growers, and some of them men of broad experience and close observation, that by stimulating the growth of an infested tree, "the tree will throw off the scale insects." As to this I cannot speak from personal experience. But testimony of this kind is so general that I am inclined to believe that it has considerable foundation in fact. Moreover, this theory is simply the converse of the one that sickly trees are more subject to the attacks of this class of insects. In any case, be these theories true or not, a healthy tree will be better able to withstand the attacks of insects, and the use of fertilizers will aid a tree in recovering from the enfeebling effects of such attacks.

METHODS OF DESTROYING SCALE INSECTS.

In many cases these pests have gained such a foothold that the destruction of a small number of trees would not suffice to free the orchards from them. And hence, to accomplish our purpose, it is necessary to be able to destroy the insects without injury to the infested trees. During the past year I have conducted many experiments with various substances which have been recommended for this purpose. In every case care has been taken to note the effect upon the plant of the substance used, as well as its efficacy as an insecticide. Next in importance to these considerations are the cost of a substance, and the relative ease with which it may be applied. These have also been carefully considered.

From the suctorial habits of this group of insects, the remedies available are evidently limited to such as destroy life by simple contact, and such as produce death when inhaled through the spiracles. The large class of poisons which require to be swallowed with the food of the insect are useless, as the food is taken from beneath the surface of the tissues of the plant, and hence beyond the reach of external applications to the plant.

Methods of applying remedies.—Certain species of scale insects confine their attacks to the bark of the trunk and larger limbs of the trees which they infest. These are very easily reached. The best method is to apply the substance used with a stiff brush, by means of which many insects may be destroyed mechanically, and the remedy brought in contact with others which are under the loose bark of the tree, and would thus be liable to escape if the remedy were applied otherwise.

But the greater number of species of this family of insects infest the bark of the smaller branches and the foliage. To reach these is a difficult matter. It can be done best by means of water and some form of force pump; the remedial agent being diluted with water and the mixture then sprayed upon the infested plants. The pump which I have used in my experiments is figured in Report for 1879, plate XIV, consists of two brass tubes, one working telescopically within the other; a hose is fastened to one end and a rose can be attached to the other; this

rose is represented in the lower part of the figure; an arrangement of valves allows water to pass into the pump through the hose, but will not allow it to return. Thus, when the smaller tube is pulled out, the pump is filled to its greatest capacity; by pushing this tube back, the water can be ejected with considerable force through the rose in a fine spray. By using a nozzle with a single opening, such as is represented upon the pump, a stream can be thrown a greater distance. In this way the topmost leaves of any orchard tree can be reached. In applying liquids on a large scale, as upon extensive orchards, the work can be done rapidly by placing the mixture in a barrel upon a wagon, and pumping directly from this barrel. In case expensive solutions are used it will probably be found desirable to collect that part which drops from the tree while the application is being made. For this purpose an apparatus can be made of canvas or strong cotton cloth supported by a frame and so arranged that the liquid which falls on it will flow into a receptable, and can thus be used again. In addition to the saving of the liquid which falls from the tree, the use of an apparatus of this kind would tend to cause the more thorough application of the remedy, as the operator would feel that what was not necessary to wet the trees would fall off and thus be saved. The great difficulty of wetting every part of the tree by a single application will in most cases render several applications necessary.

REMEDIES WHICH HAVE PROVED PRACTICABLE.—Although many substances have been recommended for the purpose of destroying scale insects, the results of our experiments tend to show that in most cases these substances are of but little value. A few of the agents, however, have been found to be both efficient and practicable. These are as follows:

Soap.—The value of soap as an insecticide has long been known; and the experiments which I tried with it were made chiefly for the sake of comparison with those made with other substances. The results, however, were so remarkable that I feel warranted in saying that taking into consideration its efficiency as a means of destroying scale insects, its effect upon plants, and its cost, there is at this time no better remedy known than a strong solution of soap. In my experiments whale-oil soap was used, and the solution was applied by means of a fountain pump to orange trees infested with the red scale of California. In the strongest solution used the proportions were three-fourths pound of soap to one gallon of water. The mixture was heated in order to dissolve the soap thoroughly; and the solution was applied while yet heated to about 100° F. The tree upon which the experiment was made was very badly infested, the bark of the trunk being literally covered with scales. Four days after the application of the solution I examined the tree very carefully and could find no living insect on the trunk of the tree, and only a small proportion of the coccids on the leaves appeared to be still alive. I was unable to examine the tree again personally, but three months later Mr. Alexander Craw, of Los Angeles, made a careful examination of this and some other trees upon which we had experimented, and on this one *he was unable to find any living scale insects.* Taking into consideration the extent to which this tree was infested, and the fact that but a single application of the solution was made, the result is remarkable.

In another experiment the solution was made as in the above and then an equal amount of cold water added. The tree experimented upon was similar to the one used for the former experiment. Four days after the application no living insects could be found on the trunk of the tree, and only a very few upon the leaves. In fact, the experiment was as

successful as could be expected, it being very difficult to reach every insect on the leaves by a single application. When Mr. Craw examined this tree three months later he found but few living insects on it.

As a result of all of my experiments with soap, I recommend the use of it in the proportion of one-fourth pound of soap to one gallon of water, repeating the application after an interval of a few days. If a cheap soap be used, which can be obtained for from four to six cents per pound, the cost of the remedy will not be great compared with what is to be gained.

Kerosene.—This is the best and cheapest of all agents for the destruction of insects where it can be applied without injury to crops or other property. But the injurious effects which are liable to follow the use of it when applied to living plants detracts greatly from its value. To what extent it can be safely used has not yet been fully determined.

We have tried many experiments but the results are not uniform. Spraying kerosene upon the leaves of cotton killed the plant. The bark of elm trees around which bands of felt saturated with kerosene had been applied was destroyed whenever the oil reached it.

In Jacksonville, Fla., I was shown orange trees the trunks of which had been wet with kerosene to destroy the scale insects, and the experiment resulted in the destruction of the greater part of the bark to which the oil had been applied. On the other hand, I have repeatedly applied the pure kerosene to the leaves of orange without any apparent result; even a young shoot, which, although two feet in length was not more than fourteen days old, was uninjured by an application of pure kerosene which thoroughly wet every leaf so that the oil flowed from them in large drops. A bark-louse (*Lecanium hesperidum*) which was very abundant upon ivy on the department grounds was destroyed by the application of pure kerosene with no apparent bad results to the vine.

The experience of Mr. Saunders in the use of kerosene in the orange house of the department has extended through several years. He gives the results of his experiments as follows:*

> Several years ago the department imported from Europe a collection of the Citrus family, embracing many varieties of the orange, lemon, lime, &c. The plants were in a very bad condition when taken out of the packages, owing to detention on the voyage and other causes; most of them were denuded of foliage and very scant of roots. They were at once planted in pots and placed under suitable conditions for growth. It soon became evident that they were badly infested with a scale insect which greatly retarded their growth and prevented their propagation and distribution. After the failure of many attempts to utterly eradicate this insect, the collection may now be said to be entirely rid of it. This has been effected by the persistent use of a small portion of coal oil applied in water. About one gill of astral oil in five gallons of water applied to the plants through a syringe on alternate days for several months has destroyed the insects without injury to the plants; weaker solutions seemed ineffective, and when the oil was increased to an appreciable degree, the young leaves and tender shoots of the oranges were injured.

The success attending Mr. Saunders's use of coal oil is due, I believe, to more persistent efforts than most horticulturists would be willing to make. Not only was the remedy thoroughly applied, but it was found necessary to repeat the application very many times.

The following experiments indicate what may be expected from single applications of this remedy:

A single application of kerosene and water, in the proportions given above, to a lime tree, destroyed only a small part of the scale insects upon it. One part of kerosene suspended in one hundred and fifty parts of water was atomized over *Lecanium hesperidum* on ivy, but no

*Report of Department of Agriculture, 1878, p. 205.

effect on the insects or foliage was discoverable, although the plant was examined daily for several weeks. Some of the same mixture was applied to mealy bugs on young orange leaves with no results. One part of oil to seventy-five of water was similarly used, but neither the insects nor the foliage were injured. One part of oil to fifty water was equally inefficient when applied to *Lecanium*. A small quantity of pure kerosene was then atomized over the scale insects on ivy. Four days later the insects were found to be dead and the vine uninjured. The experiment was repeated with similar results. Pure kerosene sprayed over a colony of the woolly apple-louse (*Schizoneura lanigera*) killed the insects at once without injuring the branch of *Crataegus* upon which they were.

Many experiments similar to the last two were tried with similar results. Still, I am unwilling to recommend the use of pure kerosene upon living plants.

The application of kerosene mixed with water is attended with obvious difficulties. The method adopted by Mr. Saunders is to place the kerosene and water together in a pail or tub, and then thoroughly mix the liquids by syringing a syringeful into the barrel several times and then, filling the syringe quickly, throw the mixture upon the trees before the oil and water separate. The great trouble attending this method of applying kerosene has led to many efforts to make an emulsion of this substance. As to the result of these efforts Prof. C. V. Riley made the following statement in the Scientific American of October 16, 1880:

> Nothing is more deadly to the insect in all stages than kerosene or oils of any kind, and they are the only substances with which we may hope to destroy the eggs. In this connection the difficulty of diluting them, from the fact that they do not mix well with water, has been solved by first combining them with either fresh or spoiled milk to form an emulsion, which is easily effected; while this in turn, like milk alone, may be diluted to any extent so that particles of oil will be held homogeneously in suspension. Thus the question of applying oils in any desired dilution is settled, and something practicable from them may be looked for.

Soon after the publication of this article I planned experiments based upon the statement in it to ascertain definitely what proportion of kerosene suspended in water by the aid of milk was most desirable for use in the destruction of scale insects. I found at once that the emulsion of milk and kerosene which I made could not be diluted with water to any great extent. Fully realizing the importance of the matter, I then made a series of more than fifty very careful experiments in order to ascertain how the desired dilution of the emulsion could be obtained. The results of these experiments were as follows:

An emulsion of kerosene and milk can be easily made by placing the fluids together in a bottle and shaking them violently for several minutes; about three minutes is the time usually required. The quantity of milk used should be at least equal to that of the kerosene. The best results were obtained when the kerosene formed only one-third of the mixture, but equal parts of kerosene, milk, and water gave as good results as one part of kerosene to two parts of milk.

For example, in one series of experiments I was unable to make an emulsion of equal parts of oil and milk; but by the addition of a third part of *either water or milk* I was able in each case to make a good emulsion. These emulsions were of a thick creamy consistence, and were very stable, no indication of a separation of the oil from the milk in one case, or from the milk and water in the other, being observable even after the emulsion had stood twenty-four hours. But as soon as water was added to the emulsion in any considerable quantity the oil

or the oil and milk together floated on the surface of the water; and no amount of shaking would serve to mix the liquids so that the mixture would be stable. It is true that in some of the experiments the emulsion separated from the water less readily than oil alone would; but in each case the mixture was of such a nature that it was necessary to stir it constantly in order to keep the oil suspended in the water.

Cole's Insect Exterminator.—This the name given to a compound which is in the market and which is highly recommended as an insecticide. Its cost is too great, however, to admit of its use except on a small scale, as in conservatories. The results of our experiments show that it is very effectual as an insecticide, and that it is harmless to growing plants, thus being all that is claimed for it. An analysis of it shows that it may be closely copied by dissolving 2 to 2.5 per cent. of green soap in 100 parts of 50 per cent. alcohol.

Tobacco.—A decoction of tobacco made by steeping .5 gram of Durham smoking tobacco in 15^{cc}. of water was fairly successful. Where tobacco can be obtained cheaply it is likely to prove of practical value for the destruction of scale insects; at least it merits a fair trial on a large scale in the field.

Snuff and sulphur.—Equal parts by bulk of smoking tobacco and flowers of sulphur were ground together in a mortar till thoroughly mixed. This compound was perfectly successful when dusted over *Lecanium hesperidum* when wet; and it adhered to the plant for a long time notwithstanding rain. Still this does not seem to me to be a remedy that will admit of successful and economical application on a large scale. It may be useful in conservatories, and upon ornamental plants.

Lye.—A small number of experiments were tried with lye; these were only partially successful. I found later, however, that lye has been used to a considerable extent in the vicinity of San José, Cal., with good results. Dr. Chapman, of that city, recommends* the use of concentrated mercantile lye in the proportion of one pound of lye to from two to four gallons of water, but suggests that the strongest solution should only be applied when the tree is dormant. I saw most excellent results in the orchard of Mr. V. C. Mason from the use of the following mixture: One pound concentrated lye, one pint gasoline or benzine, half pint oil, five gallons water.

Results of experiments with other substances.—By far the greater number of the substances with which we experimented proved to be of little or no value. In the case of some of them which have been very widely recommended by the agricultural press, we give the results of our experiments. These results are important, as they will enable the horticulturist to avoid loss of time and money in the application of inefficient substances.

Pyrethrum.—Through the kindness of Mr. G. N. Milco, of Stockton, Cal., I was furnished with an abundant supply of this valuable insecticide, and I made more careful and extended experiments with it than with any other substance. As a result of these experiments I am forced to state that, although for the destruction of certain classes of insects there is nothing better than a good quality of fresh pyrethrum powder, for the destruction of scale insects it is of very little, if any, value.

Dry pyrethrum was blown over the leaves of a tree badly infested with *Lecanium hesperidum* and *L. oleae*; so large a quantity of the powder was used that the upper surface of the leaves was made yellow with it. Although the coccids were young, many of them still crawling over the

* Pacific Rural Press, April 9, 1881.

surface of the leaves, but few were killed by the powder; and since many lady-bug larvae (*Coccinellidae*) which prey upon these coccids, and many specimens of a chalcis fly (*Tomocera Californica*) the larvae of which destroy the eggs of the black scale (*L. oleae*) were destroyed by the powder, the application of it appeared to do more harm than good. During this experiment, which was in the open air in Southern California, a layer of paper was spread upon the ground under the tree. In about ten minutes after the application of the powder the chalcis flies and coccinellid larvae began to fall upon the paper, and I believe that the number of these beneficial insects which were destroyed was greater than the number of coccids.

Infusions were made in numerous ways, with hot water and with cold, by steeping and by boiling, and of various strengths. In some the proportion of pyrethrum was nearly one-fourth pound to the gallon of water. Although the infusions were more destructive to coccids than the dry powder, in no case were they sufficiently so to be considered successful, especially when the fact that the cost of the infusion was from ten to fifteen times as great as the cost of a solution of soap which was much more efficient.

The tincture of pyrethrum was found to be much more effectual than either the infusion or the dry powder; but the cost of making a tincture precludes its use on a large scale. A tincture of the *leaves and stems* of pyrethrum was furnished me by Mr. Milco. This also was found to be very efficient; which is a very interesting fact, as it indicates that the active principle of the plant is not confined to the flowers, a point worthy of further investigation.

Alcohol.—Commercial alcohol sprayed over scale insects produced no apparent effect. The experiments were tried for the sake of comparison with those made with tinctures, in order to ascertain if the greater efficiency of the tinctures was due to the presence of the alcohol with which they are made.

Ammonia.—Dilute *aqua ammonia* was found to be valueless for the destruction of coccids, as it injured the plants more than the insects.

Carbolic acid.—A large number of experiments were tried with aqueous solutions of carbolic acid. This substance was found to be of little value in destroying coccids and quite liable to injure the foliage of the plants.

Sulphur.—Although this substance is very useful for destroying the mycelium of fungi, our experiments indicate that it possesses little value as an insecticide. It forms, however, the basis of a large part of the nostrums used by the quacks who doctor fruit trees. A common way of applying it is to bore a hole, often one inch in diameter and six inches deep, into the trunk of the infested tree; then, after putting a considerable quantity of flowers of sulphur into this hole, it is closed with a wooden plug. It is claimed that the sulphur will be taken up by the sap and carried to every part of the tree, thus reaching and destroying every insect pest that infests it. Apparently no account is taken of the important facts that the sulphur is usually placed far inside of the cambium layer, and consequently where there is but little if any circulation of the sap; and that as sulphur is insoluble in water, it would not be taken up by the sap even under the most favorable circumstances.*

*I removed from an orange tree in Florida a quantity of flowers of sulphur which had been placed in it in the way described two years previously. The sulphur was unchanged in nature, and, as I was assured by the owner of the tree, undiminished in bulk.

USEFUL PRODUCTS OF THE COCCIDAE.

Although the occasion for this report is the great injury to agriculture caused by certain species of scale insects or bark-lice, it should be borne in mind that there are insects belonging to this family which are beneficial to man. In some instances these insects or their products have been of great commercial importance, especially in ancient times; and to this date the products of certain species are used extensively.

The dye-stuff known as kermes or *granum tinctorium* is made from the dried bodies of the females of Coccus ilicis of Linnaeus, a species of bark-louse which lives upon a small evergreen oak (*Quercus coccifera*), a tree which is native of Asia and the countries bordering on the Mediterranean. This dye has been in use ever since the time of Moses; and Pliny states that the inhabitants of Iberia paid to the Romans half their tribute in kermes. The use of this dye has, however, been superseded to a great extent by cochineal, which gives colors of much greater brilliancy. Cochineal is also an insect belonging to this family; it is the *Coccus cacti* of authors, and is a native of Mexico. It feeds upon various species of the Cactaceae, more especially *Opuntia coccinilifera*. Although this insect is a Mexican species, it is now cultivated in India, Spain, and other countries, and I have received living specimens which were collected upon a wild cactus near Fernandina, Fla. The dye-stuff consists of the female insects, which, when matured, are brushed off the plants, killed, and dried. The entire insect is used. From cochineal, lake and and carmine are also prepared. Cochineal is now being superseded by aniline dyes, which are made from coal tar.

The scarlet grain of Poland (*Porphyrophora polonica*) is still another bark-louse which has been used to a considerable extent as a dye-stuff.

The stick lac of commerce, from which shell-lac or shellac is prepared, is a resinous substance excreted by a bark-louse known as *Coccus lacca* (*Carteria lacca* Ker.), which lives upon the young branches of several tropical trees, especially *Ficus Indica*, *F. religiosa*, and *Croton lacciferum*. And the coloring agent known as lac dye is also prepared from stick lac.

Another true lac insect occurs in Arizona upon the stems and branches of *Larrea mexicana*. Judging from the specimens in the museum of this department, the lac occurs on this plant in sufficient quantity to be of economic importance.

A bark-louse which was described under the name of *Coccus manniparus* (*Gossyparia maniparus* Sign.), "is found upon *Tamarix mannifera* Shr., a large tree growing upon Mount Sinai, the young shoots of which are covered with the females, which, puncturing them with their proboscis, cause them to discharge a great quantity of a gummy secretion, which quickly hardens and drops from the tree, when it is collected by the natives, who regard it as the real manna of the Israelites" (Westwood).

China wax is another substance for which we are indebted to this family. It is the excretion of an insect known as Pe-la (*Ericerus Pe-la* Westwood). In fact, many species of this family excrete wax in considerable quantities. I have found three species in this country which, if they can be easily cultivated, produce wax in sufficient quantities to be of economic importance.

DESCRIPTIONS OF SPECIES.

Subfamily DIASPINAE.

Genus **ASPIDIOTUS** Bouché.

This genus includes species of *Diaspinae*, in which the scale of the female is circular or nearly so, with the exuviae at or near the center; and the scale of the male somewhat elongated, with the larval skin at one side of the center or near one extremity. The last segment of the female usually presents four groups of spinnerets; in a few species there are five groups, and in some they are wanting.

ASPIDIOTUS ANCYLUS Putnam.

(Plate XIV, Fig. 3, Plate XXI, Fig. 4.)

Diaspis ancylus Putnam. Transactions of the Iowa State Horticultural Society for 1877, vol. xii, p. 321.
Aspidiotus ancylus Putnam. Proceedings of Davenport Academy, vol. ii, p. 346.

Scale of female.—The scale of the female is usually slightly wider than long, although nearly circular, with the exuviae laterad of the center, and covered with a thin layer of excretion. This film is white, but it is easily removed, leaving the brick-red exuviae exposed. That part of the scale immediately surrounding the exuviae is dark gray, almost black; the margin of the scale is light gray; the whole scale has a reddish tinge. It measures about 1.4^{mm} in length and 1.3^{mm} in width. Ventral scale white and very delicate.

Female.—The female is pale yellowish or pale orange in color, marked with translucent spots. The outline of the body before oviposition is ovate, but becomes more or less circular after the insect begins to oviposit. The last segment presents the following characters: (Plate XIV, Fig. 3.)

There are four or five groups of *spinnerets*. The anterior group, when present, varies from a single spinneret to six, but it rarely consists of more than three; the anterior laterals vary from six to fourteen; the posterior laterals vary from five to eight.

Only one pair of *lobes* present, these are large; each is notched at about the middle of the lateral margin; occasionally there is a small notch near the end of the lobe on the mesal margin.

There are two *incisions* of the margin of the ventral surface on each side of the meson, one just laterad of the lobe, and one laterad of the second spine. The part of the body wall bounding these incisions is conspicuously thickened.

There are two *plates* caudad of each incision; these plates are usually simple, but are sometimes toothed; occasionally there is a third plate in one or more of these places. There are three to four irregular slender plates between the third and fourth pairs of spines. The first, second, and third pairs of spines are situated as in allied species; the fourth pair is at two-thirds the distance from the lobes to the penultimate segment. Described from five specimens from maple, two from peach, seven from osage orange, twelve from hackberry, fifteen from ash, and eleven from *Staphyllea trifoliata*.

Variety.—A form of *Aspidiotus* was found, the scales of which I am unable to distinguish from those of *A. ancylus;* but the last segment of

the female presents the following difference from the typical form of this species: There are no plates between the third and fourth pairs of spines; and the vaginal opening is mesad the anterior spinnerets of the posterior lateral groups, instead of the posterior members of the same groups. The variation in the number of the spinnerets is greater in my specimens of the variety than in those of the typical form, there being in some cases seventeen on the anterior laterals, and nine in the posterior laterals. Described from twenty-one specimens from linden, eleven from beech, eighteen from oak, and four from water-locust.

Scale of male.—The scale of the male resembles that of the female in color, but is smaller and more elongated. Length 1.2^{mm}, width 0.6^{mm}.

Male.—The male is easily distinguished from all other species known to us by the small size of its wings. We have bred numerous specimens from seven species of plants: Maple, staphyllea, hackberry, ash, osage orange, peach, and water-locust. These males show considerable variation, and for a time I believed that I had two species. The extreme forms are represented by Fig. 2 and Fig. 4, Plate XXI. In each the color of the body is orange yellow; in the former, which was bred from peach, the thoracic band is dark brown, and the distal joints of the antennae are not enlarged; in the latter, which was bred from ash, the thoracic band is of the same color as the remainder of the body, and the distal joints of the antennae are conspicuously enlarged. These two forms shade into each other, and each was bred from plants which were infested by the typical females only.

Habitat.—Davenport, Iowa (Putnam), Washington, and Western New York.

ASPIDIOTUS AURANTII Maskell.

THE RED-SCALE OF CALIFORNIA.

(Plate III, Fig. 1, 1*a*, 1*b*, 1*c*, Plate XII, Fig. 1, Plate XIV, Fig. 1.)

Aspidiotus aurantii Maskell. Trans and Proc. of the New Zealand Institute, vol. xi, p. 199.

Aspidiotus citri Comstock. Canadian Entomologist, vol. xiii, p. 8.

Scale of female.—This scale resembles that of *Aspidiotus ficus* in shape, size, and the presence of the nipple-like prominence, which indicates the position of the first larval skin; but it can be readily distinguished from the scale of that species as follows: It is light gray, and quite translucent; its apparent color depending on the color of the insect beneath, and varying from a light greenish yellow to a bright reddish brown; the central third (that part which covers the second skin) is as dark and usually darker than the remainder of the scale; and when the female is fully grown the peculiar reniform body is discernible through the scale, causing the darker part of the outer two-thirds of the scale to appear as a broken ring. (Plate III, Fig. 1*b*.)

Female.—The female is light-yellow in color in the adolescent stages, becoming brownish as it reaches maturity. When fully developed the thorax extends backward in a large rounded lobe on each side, projecting beyond the extremity of the abdomen, and giving the body a reniform shape. The last abdominal segment presents the following characters: (Plate XII, Fig. 1.)

I have been unable to detect the presence of the groups of *spinnerets*, although I have examined many specimens prepared in various ways.

There are three pairs of well-developed *lobes*. The lobes of the first pair are abruptly narrowed at about half their length; the notch on the

mesal margin is often nearer the distal end of the lobe than that of the lateral margin. The lobes of the second and third pairs are abruptly narrowed at half their length on the lateral margin, and often bear a notch on the median margin near the distal end. Laterad of the most lateral plate is a triangular lobe of the *margin of the segment*, which is serrate.

The *plates* are all deeply fringed; those between the first pair of lobes on their distal margins, the others on their lateral margins. They are all well developed, exceeding the lobes in length, and are situated as follows: Two between the first pair of lobes, two between the first and second lobes of each side, two between the second and third lobes, and three between the third lobe and the lobe of the margin of the body. The first plate laterad of the second lobe, and the three plates laterad of the third lobe are each deeply bifurcated, and each bifurcation is fringed on the lateral margin.

On the ventral surface there is a *spine* near the base of the lateral margin of each of the four lobes except the first; there are also about three small slender spines on the margin of the body near the penultimate segment. On the dorsal surface there is a spine with each lobe. The first spine is very slender and inconspicuous, but as long as the lobe; it is situated at the base of the lateral margin of the lobe in such a manner that it can be moved either above or below the lobe. Each of the other spines is situated near the middle of the base of the lobe it accompanies.

Egg.—I have not seen the eggs of this species, excepting those taken from the body of the female. And as I have repeatedly found young larvae under the scales I am led to believe that the species is viviparous.

Scale of male.—The scale of the male resembles that of the female, excepting that it is only one-fourth as large; the posterior side is prolonged into a flap, which is quite thin; and the part which covers the larval skin is often lighter than the remainder of the scale.

Male.—The male is light yellow, with the thoracic band brown, and the eyes purplish black. The outline drawing on Plate XIII, Fig. 1, represents the shape of the various organs.

Habitat.—I have observed this species in several groves at San Gabriel and Los Angeles, Cal. At the first-named place, where it is very abundant, it is said to have first appeared on a budded orange tree which was purchased by Mr. L. J. Rose, at one of the hot-houses in San Francisco. At Los Angeles it appears to have spread from six lemon trees which were brought from Australia by Don Mateo Keller.

At first I considered this an undescribed species, as I could find no description of it either in American or European entomological publications. I therefore described it in the Canadian Entomologist under the name of *Aspidiotus citri.* Afterwards I obtained copies of the papers "*On some Coccidae in New Zealand,*" by W. M. Maskell, published in the Transactions and Proceedings of the New Zealand Institute, and found that he had described an insect infesting oranges and lemons imported into New Zealand from Sydney which was either identical with or very closely allied to the red scale of California. I at once sent to Mr. Maskell for specimens of the species described by him. These have just been received and prove to be specifically identical with those infesting citrus trees in California. Thus the question as to source from which we derived this pest is settled beyond a doubt.

I have found *Aspidiotus aurantii* only on citrus trees. It infests the

trunk, limbs, leaves, and fruit. The infested leaves turn yellow, and when badly infested they drop from the tree. This species spreads quite rapidly; and from what I have seen of it, I believe that it is more to be feared than any other scale insect infesting citrus fruits in this country. As illustrating the extent of its ravages in Australia, Dr. Bleasdale told me of a grove of thirty-three acres which nine years ago rented for £1,800 per year, and for which three years ago only £120 rent could be obtained.

Specimens of this insect colonized on orange trees in the breeding room of the department passed through their entire existence in a little more than two months; hence it is probable that in the open air in Southern California there are at least five generations each year, and possibly six. The mode of the formation of the scale in this species very closely resembles that of *A. ficus*, described at length in this report. The ventral scale, however, reaches a greater degree of development in *A. aurantii* than in *A. ficus*. At first it consists of a very delicate film upon the leaf; when the second molt occurs it is strengthened by the ventral half of the cast skin, the skin splitting about the margin of the insect, the dorsal half adhering to the dorsal scale and the ventral half to the ventral scale. Later, after the impregnation of the female, the ventral scale becomes firmly attached to the dorsal scale and to the insect; so that it is almost impossible to remove an adult female from her scale.

ASPIDIOTUS CONVEXUS, new species.

THE CONVEX SCALE.

(Plate XII, Fig. 8.)

This species, which is very common on the bark of the trunk and limbs of the native willows in California, very closely resembles *Aspidiotus rapax* in the shape and color of its scale. The resemblance of the two species is so great that at first I considered them identical, and concluded that *A. rapax* had spread to the cultivated trees in California from the native willows of that State. But a careful study of the structure of the two forms show them to be specifically distinct. The most striking differences are those presented by the last abdominal segment of the female. In this species there are four groups of spinnerets; the superior laterals consisting of about seven, and the inferior laterals of about four. In *A. rapax* the groups of spinnerets are wanting.

In this species the plates are very much shorter than in *A. rapax*, and very closely resemble the plates in *A. ancylus*. But *A. convexus* differs greatly from *A. ancylus* in the shape and color of the scale and in the wings of the male being long. Described from seven females, two males, and very many scales.

ASPIDIOTUS CYDONIAE, new species.

THE QUINCE SCALE.

(Plate XIV, Fig. 1.)

Scale of female.—The scale of the female is indistinguishable from that of *Aspidiotus rapax*, described in this report.

Female.—The last segment of the body of the female presents the following characters:

There are four groups of *spinnerets*. The anterior laterals consist of eight or nine each, and the posterior laterals of from five to seven each.

There are only one pair of *lobes*, the median, visible; these are well developed. Each lobe is notched on each side; the notch on the mesal margin is slightly distad the one on the lateral margin.

The margin of the ventral surface of the segment is deeply incised, as in *A. rapax* and allied species, there being two incisions on each side of the meson.

The *plates* are of two kinds: the first is simple, tapering, and rather short; the second is toothed and long, extending caudad as far as the tips of the median lobes. Of the first kind, there are two between the median lobes, one on each side between the incisions, and from one to three laterad of the second incision. Of the second kind, there are on each side two caudad of the first incision, and three caudad of the second incision.

The *spines* of each surface are situated as follows: first, near the base of the lateral margin of the lobe; second, between the first and second incisions; third, laterad of second incisions; fourth, about midway between the third and the penultimate segment. Described from eighteen females.

Habitat.—Upon quince in Florida.

This species is very closely related to *A. rapax* and *A. convexus*. It is easily distinguished from the former by the presence of the groups of spinnerets, and from the latter by the number of incisions in the posterior margin of last segment of female, there being three pairs in *A. convexus*, and only two in *A. cydoniae*, and in the length and size of the plates. (Compare Plate XII, Fig. 8, and Plate XIV, Fig. 1.)

ASPIDIOTUS FICUS Riley MSS.

THE RED SCALE OF FLORIDA.

(Plate III, Fig. 2.)

Chrysomphalus ficus Riley MSS. Ashmead, American Entomologist, 1880, p. 267.
Aspidiotus ficus Comstock, Canadian Entomologist, vol. xiii, p. 8.

Scale of female.—The scale of the female is circular, with the exuviae nearly central; the position of the first skin is indicated by a nipple like prominence, which in fresh specimens is white, and is the remains of a mass of cottony excretion, beneath which the first skin is shed. The part of the scale covering the second skin is light reddish-brown; the remainder of the scale is much darker, varying from a dark reddish-brown to black, excepting the thin part of the margin, which is gray. When fully grown the scale measures 2^{mm} (.08 inch) in diameter. In some specimens the part covering the exuviae is depressed, and when the scale is removed from the leaf and viewed under a microscope with transmitted light, the exuviae, which are bright yellow, show through this part, causing it to appear as described by Mr. Ashmead. This scale is represented on Plate III, Fig. 1; natural size, Fig. 2, enlarged.

Female.—The body of the female is nearly circular; it is white, marked with irregular yellow spots. The last segment presents the following characters: Plate XII, Fig. 2.

There are four *groups of spinnerets*; the anterior laterals consist each of about eight, and the posterior laterals of about four.

There are three pairs of well-developed *lobes*. The first and second lobes of each side are abruptly narrowed toward their posterior extremities on the lateral edges at about one half their length; the third lobe is narrowed by a succession of notches on its lateral margin; all the lobes are widened slightly toward their bases on their mesal margins.

The *lateral margin* of the segment appears to be of the same structure as the lobes; it is serrate, deeply notched two or three times, and ends posteriorly in a lobe.

There are six *thickenings of the body wall* on each side of the meson. These are linear, oblong, with the anterior ends rounded and slightly expanded, and are more or less nearly parallel with the meson. One arising from the mesal margin of first lobe exceeds it a little in length; one from the lateral margin of the same lobe extends nearly to the anus; one each from the mesal margins of the second and third lobes are about twice the length of the lobes, and with the anterior extremities farther from the meson than the posterior; one from a point about midway between the second and third lobes extends anteriorly beyond any of the other thickenings; and finally one from the lateral margin of the third lobe is short, inconspicuous, and sometimes wanting.

Between the first pair of lobes are two wide oblong *plates*, with the distal margin of each deeply fringed; between the first and second lobes of each side are two, and between the second and third lobes are three similar plates; between the third lobe and the one at the end of the thickened lateral margin are three large compound plates, each consisting of two long branches, which are toothed deeply and irregularly on their lateral edges.

On the ventral surface near the margin of the segment are situated four pairs of *spines*, there being a spine at the base of the lateral margin of each lobe, including the lobe of the thickened margin of the segment described above. On the dorsal surface there are only three pairs of spines, none being present on the first pair of lobes; each spine is situated near the middle of the base of the lobe it accompanies.

Egg.—The eggs are pale-yellow.

Scale of male.—The scale of the male is about one-fourth as large as that of the female; the posterior side is prolonged into a thin flap, which is gray in color; in other respects the scale appears like that of the female. (Plate 1, Fig. 3.)

Male.—The male is light orange-yellow in color, with the thoracic band dark brown and the eyes purplish-black. It very closely resembles the males of *A. aurantii*, but differs from that species in being a smaller insect, with shorter antennae, longer style, wider thoracic band, and with the pockets of the wings for the insertion of the hair of the poisers farther from the body.

Development of the insect and formation of the scale.—The development of this insect from the egg to the adult state was followed through five generations. I give, however, only the substance of a part of the notes taken on a single brood—the second one observed—as that will be sufficient for our purpose. The observations were made upon specimens which were colonized on small orange trees in pots in my office in Washington. The rate of the development of the insects was probably slower than would have been the case in the open air in Florida.

April 12, 1880, specimens of orange leaves infested by this scale were received from Mr. G. W. Holmes, Orlando, Fla. At this date males were found both in the pupa and adult state. The females also varied in size, and some of them were ovipositing. Eggs were placed on an orange tree for special study.

April 13, the eggs began to hatch. The newly-hatched larva (Plate III, Fig. 2 *c*) is broadly oval in outline and yellow in color. The antennae are five-jointed; the three basal joints are very short and nearly equal in length; the fourth and fifth joints are each longer than the three basal joints together. The fifth joint is strongly tuberculated at tip so as to appear bifurcated. The eyes are prominent and of the same color as the body. The young larvae are quite active, but they settle soon after hatching. Some settled the same day that they hatched.

April 14, it was found that the young lice, although only twenty-four hours old, had formed scales which completely concealed them from sight. These scales resembled in appearance the fruiting organs of certain minute fungi. They were white, circular, convex, with a slightly depressed ring around the central portion (Plate III, Fig. 2 *d*); their texture was quite dense, and they were not firmly attached to either the insects or the leaf, a slight touch being sufficient to remove them without disturbing the larvae. The larvae had not changed in appearance, and were able to move their legs and antennae.

April 15, the lice had not changed perceptibly. The scales had become higher and more rounded.

April 16, the lice had contracted considerably, being now nearly circular, at least as broad as long; in other respects there was no apparent change. The scales were found to vary somewhat; those most advanced having the central portion covered with a loose mass of curled white threads. Plate III, Fig. 2 *e*.

April 17, there was apparent no further change in the larva; but the mass of threads covering the central part of the scale was found in some specimens to have greatly increased in size, equaling in height three or four times the width of the scale. This mass is cottony in appearance, and in those specimens where it is largest is more or less in the form of a plate twisted into a close spiral (Plate III, Fig. 2 *f*).

April 19, not much change was apparent in the larva, but the mass of cottony excretion upon some of the scales had increased enormously; so that in some cases it extended in a curve from the scale to a point five times the width of the scale above the leaf and down to the leaf.

April 20, no important change was observed either in the larvae or scales.

April 21, it was observed that the larvae had become more or less transparent, and marked with large irregular yellow spots near the lateral margin of the head and thorax, and with a transverse row of similar spots across the base of the abdomen; the tip of the abdomen is very faintly yellow.

April 22, no important change was noted.

April 23, it was observed that the scales appeared faintly reddish in color with the center white; the reddish color, however, was due in part to the body of the larva, which is now orange-red, showing through the scale. It should be noted that in only a part of the specimens did the cottony mass become enlarged as represented in Fig. 2 *f*. The greater part of the scales remained until this date of the form shown in Fig. 2 *e*, and the cottony spirals have now disappeared, probably having been blown away.

April 24, some of the larvae had become deep orange in color.

April 26, most of the scales had become deep orange in color with the central part white; some had at the center a small nipple-like protuberance; others still preserved a short tuft of a cottony excretion. This tuft is either removed by wind or otherwise, or it becomes compact, melted, as it were, to form the nipple-like projection referred to above.

April 28, the insects appeared as they did two days ago; the scales had become very tough, and it was with difficulty that they could be removed from the insect.

April 30, the insects still remained apparently unchanged. Some of the scales were only about one-half as large as others, and still remained perfectly white; these proved to be male scales. All the scales at this date had an elevated ring on the disk with a central nipple.

May 3, many of the larvae began to show that they were about to molt, the form of the next stage being visible through the skin of the insect.

May 5, nearly all of the larvae had molted; they were now orange-yellow, with the end of the body colorless. The last abdominal segment now presents the excretory pores which are represented in the drawing of the corresponding segment of the adult female. (Plate XII, Fig. 2.) The molted skin adheres to the inside of the little scale, and therefore cannot be seen from the outside. The scales are now pink, or rose colored, with the center white.

May 14, the insects had become a somewhat paler yellow, with the anal segment slightly darker. Most of the scales were now dark purple. On removing an insect a very delicate round white plate was observed adhering to the leaf where the mouth parts were inserted.

May 18, the male scales were fully grown. At this stage they were dark reddish brown in color, with the center white, and the posterior side, which is elongated, gray. At this date some of the males had transformed to pupae; others were still in the larva state; these larvae were covered with roundish, more or less confluent yellow spots, leaving only the margin colorless; the end of the body was pale orange. The newly-transformed pupae resembled in markings the larvae just described. None of the females had yet molted the second time; their color was deep orange.

May 21, nearly all of the males had changed to pupae. It was observed that the last larval skin is pushed backwards from under the scale, to the edge of which it frequently adheres.

May 24, none of the male pupae had transformed to the adult state.

May 29, it was found that during the five days previous more than one-half of the males had issued, and the remainder, though still under the scales, were in the adult state. It was now forty-seven days from the time the larvae hatched.

June 2, no males could be found; the females were about one-half grown, and were whitish with irregular yellow spots.

June 9, eggs were observed within the body of a female.

June 17, it was found that one of the females had deposited nine eggs, of which six had hatched. This is sixty-six days from the hatching of the egg, and probably about twenty days after impregnation of the female.

The insects of this brood continued to oviposit until July 1.

Number of generations per year.—This insect, living on orange trees in a room on the north side of a building in Washington, passed through five generations in less than one year; the average time occupied by a single generation was a little less than seventy days. It is probable that in the open air in Orange County, Florida, there are at least six generations each year.

Habitat.—Although I have carefully explored many orange groves in Florida and California, and have had an extensive correspondence with orange-growers, I have been unable to find this species in the last-named State, and have found it only in a single grove in Florida. This

is the grove of Messrs. Holmes and Robinson, near Orlando, in Orange County. The insects were first observed here in the spring of 1879 on a sour-orange tree which was brought from Havana, Cuba, in 1874. On learning these facts I sent specimens to a friend at Havana in order to ascertain if the species occurred there. He at once returned me other specimens with the information that it is a very common pest in public gardens of that city.

This species infests the limbs, leaves, and fruit indiscriminately. In the grove of Messrs. Holmes and Robinson it has spread slowly. The large trees which are infested do not seem to suffer much from it, but the young trees are greatly injured by it. Mr. Holmes considers the disfiguring of the fruit as the worst feature of the pest. The insect has multiplied to such an extent upon the trees upon which I colonized it in my breeding-room, that nearly all of them have been destroyed. The species is certainly one that is greatly to be feared, and there is no doubt that it would be a good investment for the orange-growers of Florida to eradicate the pest, even if in doing so it is found necessary to purchase and destroy all infested trees. This could be done now easily, but if delayed a few years the species will doubtless become permanently established.

ASPIDIOTUS JUGLANS-REGIAE, new species.

THE ENGLISH WALNUT SCALE.

(Plate XIV, Fig. 2.)

Scale of the female.—The scale of the female is circular, flat, with the exuviae laterad of the center; it is of a pale grayish brown color; the exuviae are covered with secretion; the position of the first skin is indicated by a prominence which is pink or reddish brown. The ventral scale is a mere film which adheres to the bark. Diameter of scale, 3^{mm} (.13 inch).

Female.—The color of the female when fully grown is pale yellow with irregular orange-colored spots; oral setae and last segment dark yellow. This segment presents the following characters: There are either four or five groups of *spinnerets;* the anterior group is wanting or consists of from one to four spinnerets, the anterior laterals consist of from seven to sixteen, and the posterior laterals of from four to eight.

There are two or three pairs of *lobes.* The median lobes are well developed, but vary in outline; the second lobe of each side is less than one-half as large as the median lobes, elongated, and with one or two notches on the lateral margin; the third lobe is still smaller and pointed, or is obsolete.

There are two pairs of incisions of the margin, one between the first and second lobes of each side, and one between the second and third lobes; they are small, but are rendered conspicuous by the thickenings of the body wall bounding them.

The *plates* are simple, inconspicuous, and resemble the spines in form. The larger ones are situated one caudad of each incision.

The *spines* are prominent, especially those laterad of the second and third lobes; the fourth spines are a little nearer the first lobes than the penultimate segment; and the fifth are near the penultimate segment; there is also a spine at or near the union of the last two segments.

Scale of male.—The scale of the male resembles that of the female in

color; it is elongated, with the larval skin near the anterior end; this skin is covered by excretion, but its position is marked by a rose-colored prominence, as in the scale of the female; the anterior part of the scale is much more convex than the posterior prolongation, which is flattened. There is a rudimentary ventral scale in the form of two narrow longitudinal plates, one on each side of the lower surface of the scale. Length, 1.25mm (.05 inch).

Male.—Only dead males have been found; these were too much shriveled to be of use for description.

Habitat.—On the bark of the larger limbs of English walnut (*Juglans regia*), at Los Angeles, Cal. Described from sixty-three females; and many scales of each sex.

My attention was called to this interesting species by Mr. J. W. Wolfkill, of Los Angeles, who rendered me valuable assistance in my investigations in that locality.

There are in the collection of the department specimens of *Aspidiotus* from locust, pear, and cherry, from New York and District of Columbia, which apparently belong to this species.

ASPIDIOTUS NERII Bouché.

Aspidiotus nerii Bouché, Schädl. Gart. Ins. (1833), 52.
Diaspis bouchéi Targioni-Tozzetti (1867), Stud. sul. Coccin.

(Plate IV, Fig. 1, Plate XV, Fig. 1.)

Scale of the female.—The scale of the female is flat, whitish, or light gray in color, and with the exuviae central or nearly so (Fig.—). Exuviae dull orange yellow; the first skin usually showing the segmentation distinctly, the second skin more or less covered with secretion, often appearing only as an orange-colored circle surrounding the first skin. Ventral scale a mere film applied to bark of plant. Diameter of fully-formed scale, 2mm (.08 inch).

Female.—The body of the adult female is nearly circular in outline, with the abdominal segments forming a pointed projection; light yellow in color, mottled with darker yellow; the last segment presents the following characters:

The anterior lateral groups of *spinnerets* consist each of about nine, and the posterior laterals of about seven.

There are three pairs of *lobes;* the first and second are well developed, the third are quite small.

The *plates* are well developed; they are long and usually fringed; there are two small ones between the median lobes; those of each side are as follows: two between the first and second lobes; three between second and third lobes; and usually seven laterad of the third lobe, of which usually four are fringed and three simple. The number of the last-named group varies from four to nine.

There is on each surface of the segment a *spine* accompanying each lobe; one between the fourth and fifth plates laterad of third lobe, and one at about one-third the distance from this spine to the penultimate segment. In each case the spine on the ventral surface is a little laterad of the one on the dorsal surface.

Eggs.—The eggs are very light yellow in color.

Scale of male.—The scale of the male is slightly elongated, with the larval skin nearly central; it is snowy white with the larval skin light yellow; longest diameter, 1mm (.04 inch) (Fig. 1*f*).

Male.—The adult male is yellow mottled with reddish brown, central part of thoracic band reddish. Other characters represented in Fig. 1*a*.

Habitat.—This is a very common European species which infests many different plants, and it is spread throughout our country from the Atlantic to the Pacific, and from the Great Lakes to the Gulf of Mexico. I have found it more abundant on acacias in California than elsewhere, and for a time believed that it had been introduced from Australia with this tree. Many trees were found the leaves of which were completely covered with the scales, appearing as if they had been coated with whitewash. Leaves of magnolia were received from Mr. C. H. Dwinelle, Berkeley, Cal., which were infested to a similar extent. The following is a list of the plants upon which I have studied this species: Acacia, Magnolia, oleander, maple, Yucca, plum, cherry, currant, and Melia (*Melia azéderach*) in California; oleander in Utah; English ivy in a conservatory at Ithaca, N. Y.; ivy and "China tree" from Dr. R. S. Turner, Fort George, Fla.; grass and clover growing in pots with orange trees upon which I was rearing the scale at this department; lemons imported from the Mediterranean by a San Franciso dealer; and lemons forwarded to me by Mr. Alex. Craw from the grove of Mr. Wolfkill, at Los Angeles, Cal.

The scales upon magnolia from Berkeley, Cal., and upon oleander from Salt Lake City appear somewhat different from those on acacia and other plants. But after a very careful study of the different forms from each plant, I am unable to point out any character which will distinguish those on magnolia and oleander from others.

Specimens of infested lemons from Europe were forwarded to me at Washington by the editor of the Riverside Press and Horticulturist, who had received them from a correspondent in San Francisco, who had imported them from the Mediterranean. Notwithstanding the great distance (once across the Atlantic and twice across the continent) which this fruit had been transported, the insects infesting it were alive and in a healthy condition. This illustrates the ease with which these insects may spread from one country to another, and the dangers attending the introduction of foreign fruit and nursery stock.

The appearance of this pest upon citrus fruits in Southern California is greatly to be regretted, for the species is already so common on other plants that it may be difficult to keep the orange groves free from it. The fact, however, that it infests acacia, oleander, and other plants to such a great extent, and has been observed but few times in this country on citrus fruits, may be taken as an indication that it is not liable to multiply to any great extent upon oranges and lemons.

In the specimens which I have seen the leaves of the lemon were not infested, but the scales were very abundant on the fruit.

The young of this insect which were found on ivy in Florida were colonized on an orange tree in the breeding-room of the department. When one day old the larvae had settled and commenced excreting a covering; when four days old this covering was quite dense; on the twentieth day some larvae molted, and on the twenty-eighth day the second molt occurred. It was observed that this molt was accomplished by a splitting of the skin at the sides of the body, so that the dorsal half of the skin became attached to the scale and the ventral half to the leaf. Soon after this molt all the specimens died. This was an indication that this species could not mature upon the orange. But a very careful study of the form from Florida has failed to reveal any character by which it can be separated from that living on lemon in California.

Although I failed to ascertain the time occupied by a single genera-

tion, the following notes indicate that there are at least two each year, and probably more. On the 13th of April, 1880, specimens of magnolia leaves were received from Berkeley, Cal., infested by this insect. The eggs were hatching from this date till 27th April. During this time (22d April) leaves of ivy were received from Florida, upon which were scales and newly-hatched young of this species. On the 21st of May other specimens were received from Florida; of these the females were about one half grown, and the males were in the pupa state.

On the 24th of August I observed again at Los Angeles, Cal., the eggs of this species.

During April adult males emerged in my breeding-cages from both the California (Berkeley) and Florida specimens. And during August the males were again flying at Los Angeles, Cal.

In conservatories there is apparently no regularity in the periods of this insect; for specimens of all stages, from the egg to the adult, may be observed at the same time.

ASPIDIOTUS OBSCURUS, new species.

THE OBSCURE SCALE.

(Plate XII, Fig. 4, Plate XIII, Fig. 4.)

Scale of female.—The scale of the female is very dark gray, agreeing in color with the bark to which it is attached; and as it is only slightly convex, its presence is difficult to detect. It is somewhat irregular in outline, but nearly circular. The exuviae are between the center and one side; their position is indicated by a nipple like prominence, which is marked, as in many other species, with a white dot and concentric ring of the same color. The ventral scale consists of a delicate film of white excretion, and the lower half of the exuviae attached to the bark. Diameter of scale, 3^{mm} (.12 inch).

Female.—The body of the fully-grown female is reniform, being only four-fifths as long as wide, and having the lobes of the penultimate segment extending back nearly as far as the end of the body. The segmentation of the body is very indistinct; the color is a yellowish brown. The last segment presents the following characters: (Plate XII, Fig. 4.)

There are five groups of *spinnerets;* the median consists of about six, the superior lateral of about twelve, and the inferior lateral of about eight. The oval pores opening on the dorsal side of the body are to be seen very distinctly from below.

There are three pairs of well developed *lobes*. The first lobe of each side is conical, tapering anteriorly, and with the distal margin rounded; there is often a small notch on the lateral side. The distal margins of the second and third lobes are serrate.

The thickened part of the *lateral margin* of the segment becomes narrower anteriorly until near the penultimate segment it is a mere line. It is irregularly notched and is terminated posteriorly by a prominent lobe.

There are seven short club-shaped *thickenings* of the body wall upon each side of the meson. Each thickening is rounded anteriorly and tapers posteriorly. They are situated as follows: one terminating near the lateral margin of the first lobe, one at each side of second lobe, one midway between second and third lobes, one at each side of third lobe, and one near the posterior end of the thickened lateral margin This one is often obsolete. Those terminating at the median sides of the sec-

ond and third lobes are narrower and shorter, and have their anterior ends directed laterad more than the others. The remaining thickenings are of about the same length as the median lobes.

The *plates* are inconspicuous, and in no case extend as far as the lobes. There is one between the median lobes, one between the first and second lobe of each side, two between the second and third lobes, and two between the third lobe and the posterior end of the thickened lateral margin. The last two are unequally bifid, the other four are simple and truncate.

On the ventral side the first pair of *spines* is obsolete, the second and third pores are situated at the base of the lateral margins of their respective lobes, the fourth pair is just laterad of the lobe of the lateral margin, and a fifth pair is situated about one-third the distance from this lobe to the penultimate segment. On the dorsal side the first pair is also obsolete, each member of the other four pairs is situated in little mesad of the corresponding spine on the ventral surface.

Egg.—The eggs have not been observed, and several specimens of females in the collection indicate that the species is viviparous.

Scale of male.—The scale of the male is oval in outline with the protuberance covering the larval skin near the anterior end. This scale is of the same color as that of the female.

Length, a little more than 1^{mm} (.04 inch); breadth nearly $\frac{1}{2}$^{mm} (.02 inch).

Habitat.—On the bark of the limbs of willow oak (*Quercus phellos*) at Washington, D. C.

Described from forty females, and very many scales of each sex.

The scale of this species resembles very much that of *Aspidiotus tenebricosus* which occurs on red maple. That scale, however, is much more convex than this one, and its diameter is only one-half as great.

ASPIDIOTUS PERNICIOSUS, new species.

THE PERNICIOUS SCALE.

(Plate XII, Fig. 7.)

Scale of female.—The scale of the female is circular and flat, with the exuviae central, or nearly so. The scale is gray, excepting the central part, that which covers the exuviae, which varies from a pale yellow to a reddish yellow; sometimes the central part is black, resembling the scale of the male, and in some specimens the outer part of the scale is marked by radiating ridges. Diameter, 2^{mm} (.08 inch).

Female.—The body of the female is yellowish and almost circular in outline; the segmentation is distinct, though not conspicuous. The last segment presents the following characters:

There are only two pairs of *lobes* visible; the first pair converge at tip, are notched about midway their length on the lateral margin, and often bear a slight notch on the mesal margin near the tip. The second pair are notched once on the lateral margin.

The margin of the ventral surface of the segment is deeply incised twice on each side of the meson; once between the bases of the first and second lobes and again laterad of the second lobe. On each side of each of these incisions is a club-shaped thickening of the body wall.

There are two inconspicuous simple *plates* between the median lobes, and on each side two similar plates extending caudad of the first incision, three small plates serrate on their lateral margin caudad of the second incision, and the club-shaped thickenings of the body wall

bounding it, and three wide prolongations of the margin between the third and fourth spines. These prolongations are usually fringed on their distal margin. There are also in some, irregular prolongations of the margin between the fourth spine and the penultimate segment.

The first and second spines are situated laterad of the first and second lobes, respectively; the third spine laterad of second incision; and the fourth spine about half the distance from the first lobe to the penultimate segment.

Egg.—The eggs are white.

Scale of male.—The scale of the male is black, and is somewhat elongated when fully formed. The larval skin is covered with secretion; its position is marked by a nipple-like prominence which is between the center and the anterior margin of the scale. The scale of the male is more abundant than that of the female.

Male.—The male has not yet been observed.

Habitat.—On apple, pear, plum, and other trees in Santa Clara County, California.

Described from thirty females and very many scales of each sex.

I regret that as yet I have been able to study this very important pest but little. From what I have seen of it, I think that it is the most pernicious scale insect known in this country; certainly I never saw another species so abundant as this is in certain orchards which I have visited. It is said to infest all the deciduous fruits grown in California, excepting peach, apricot, and the black tartarean cherry. It attacks the bark of the trunk and limbs as well as the leaves and fruit. I have seen many plum and apple trees upon which all the fruit was so badly infested that it was unmarketable. In other instances I have seen the bark of all of the small limbs completely covered by the scales. In such cases the wood beneath the bark is stained red.

This species is easily destroyed by strong alkaline washes, as is shown by the results of experiments given in the chapter on remedies.

ASPIDIOTUS PERSEAE, new species.

THE RED BAY SCALE.

(Plate XII, Fig. 3; Plate XIII, Fig. 3.)

Scale of female.—The scale of the female is circular, flat, with the exuviae nearly central and covered with secretion. The outer part of the scale is dark redish brown; that part covering the exuviae varies from a very dark gray to black. The ventral scale is a very delicate film which adheres to the leaf. The scale of this species closely resembles that of *Aspidiotus ficus* in form in the presence of the nipple-like prominence which indicates the position of the first skin, and in the color of the outer part of the scale. It is, however, smaller, and has the central part darker than the remainder of the scale, instead of lighter as with *A. ficus.* Diameter, 1.5^{mm}–2^{mm} (.06–.08 inch).

Female.—The color of the female is orange. The body is nearly as wide as long. The last segment presents the following characters (Plate XII, Fig. 3):

There are four groups of *spinnerets;* the anterior laterals consist of from ten to twelve, and the posterior laterals of about eight.

There are three pairs of well-developed *lobes* present; each lobe is wider than long; the first lobe of each side is the smallest, the third the largest; the second is usually notched; the third is serrate.

The posterior half of the *lateral margin of the segment* appears to be of the same structure as the lobes; it is serrate, and usually more or less deeply notched four or five times.

The body wall is furnished with seven *thickenings* on each side of the meson. These thickenings are long, somewhat club-shaped, the anterior part being enlarged and rounded. There is one terminating at the base of each margin of each lobe. Those ending at the base of the lateral margins of the lobes are much longer than the others. The seventh thickening terminates between the second and third lobes, and is narrow and inconspicuous.

The *plates* are small, inconspicuous, and irregularly toothed. There are two between each pair of lobes and between the third lobe of each side and the posterior lobe of the thickened lateral margin. The plates increase in size from the meson laterad.

On the ventral side there are four pairs of *spines*, there being a spine at the base of the lateral margin of each lobe and one at the anterior end of the thickened part of the lateral margin of the segment. On the dorsal side there are only three pairs of spines, there being none on the first lobes. Those of the second and third lobes are situated near the middle of the bases of the lobes; the third spine is nearly opposite the fourth spine of the ventral surface.

Eggs.—The eggs are slender and pointed at one extremity.

Habitat.—Cedar Keys, Fla., on the leaves of red bay (*Persea carolinensis*).

I collected the scales during February, at which time eggs were found under some of them; a male pupa was also observed at that time.

ASPIDIOTUS? PINI, new species.

(Plate XV, Fig. 2; Plate XVI, Fig. 2; Plate XXI, Fig. 7.)

Scale of female.—The scale of the female is much elongated, with its sides parallel and ends rounded. The exuviae are nearly central, and are covered with secretion. The color of the scale is dark gray, often approaching black, with the margin lighter, and sometimes with a bluish, brownish, or purplish tinge. In many specimens of the fully formed scale the part covering the exuviae is more or less distinct, appearing like a small scale with a light margin superimposed upon a larger scale. Length of scale, 2^{mm}–3^{mm} (.08–.12 inch); width, $.4^{mm}$–1^{mm}.

Female.—The last segment of the female presents the following characters (Plate XV, Fig. 2, and Plate XVI):

The *spinnerets* are more or less elongated, and are arranged in two groups, which occupy the position of the anterior laterals in other species. Each group consists of from eleven to sixteen spinnerets.

The *lobes* are quite small; the first and second of each side are abruptly narrowed near the distal extremity; the third lobe is notched once or twice. About one-third of the distance from the third lobe to the penultimate segment is a lobe of the lateral margin of the body of about the size of the third lobe.

The *plates* are short and irregular; there are two with distal extremities fringed between the median lobes; two similar to these between first and second lobe of each side; the lateral member of this pair of plates is much wider than the mesal one; between the second and third lobes are usually four plates each with its lateral margin fringed; between the third lobe and the lobe on the lateral margin of the segment are four or five plates similar in form to those between the second and third lobes; two of these plates are usually very small. The segment is narrowed caudad by a succession of notches as shown in Fig. 2.

The *spines* of the dorsal surface are quite large; there is one laterad of first lobe; one upon the center of each of the second and third lobes, and one upon the lobe of the lateral margin of the body. On the ventral surface the first spine is obsolete; the second, third, and fourth are each laterad of corresponding spines on dorsal surface; of these the second spine is small, the others large.

Scale of male.—The scale of the male resembles very much the central part of the scale of the female; it is somewhat narrower and darker, being almost black, and with a greenish tinge. The larval skin is cephalad of the center of the scale, and is brownish yellow.

Male.—The body of the male is orange yellow; thoracic band brown; eyes dark brown; antennae (excepting basal joint which is of the same color as body), legs, and stylet dusky. (Plate XXI, Fig. 7.)

Habitat.—Very abundant on the leaves of pitch pine (*Pinus rigida*) at Ithaca, N. Y. I also collected it on the leaves of yellow pine (*Pinus mitis*) at Macon, Ga.

This species differs greatly from all species of Aspidiotus known to me, not only in the characters of the last segment of the female as shown in Fig. 2, but in the development of the body of the female, as I hope to show at some future time.

ASPIDIOTUS RAPAX, new species.

THE GREEDY SCALE INSECT.

(Plate XII, Fig. 6.)

Scale of female.—The scale of the female is very convex, with the exuviae between the center and one side, and covered with secretion. The scale is gray, somewhat transparent, so that it appears yellowish when it covers a living female; the prominence which covers the exuviae is dark brown or black, usually with a central dot and concentric ring, which are white. Ventral scale snowy white, usually entire. Diameter, $1\frac{1}{2}^{mm}$ (.06 inch).

Female.—The body of the female is nearly circular in outline, bright yellow in color with more or less translucent blotches. The last segment presents the following characters: The groups of *spinnerets* are wanting.

Only one pair of well-developed *lobes*, the median, present. These are prominent. Each one is furnished with a notch on each side; the notch on the mesal margin is distad of that on the lateral margin. The second and third pairs of lobes are represented by the minute pointed projections of the margin of the body.

The margin of the ventral surface of the segment is deeply incised twice on each side of the meson; once laterad of the first lobe, and again between the rudimentary second and third lobes. The parts of the body wall forming the margin of these incisions are conspicuously thickened.

There are two simple tapering *plates* between the median lobes, two deeply and irregularly toothed or branched plates extending caudad of each incision, one usually simple and tapering plate between the incisions of each side, and two or three of the same character laterad of the second incision.

The first, second, and third pairs of spines of each surface are situated near the lateral bases of the first, second, and third lobes respectively; the fourth pair are situated at a little more than one-half the distance from the median lobes to the penultimate segment. In each case the

spine on the ventral surface is but little laterad of the one on the dorsal surface.

Egg.—The eggs and newly hatched larvae are yellow.

Male.—Only dead and shriveled males have been observed.

Habitat.—On the bark of the trunk and limbs as well as the leaves and fruit of various trees and shrubs in California and Florida.

Described from seventy-five females and very many scales.

I have named this the greedy scale insect on account of the great number of plants upon which the species subsists. It also occurs in some localities in great numbers, being very destructive. This is in especially the case on *Euonymus japonicus* at Fort George, Fla.; and in California on olive near San Buenaventura, and on mountain laurel (*Umbellularia californica*) at San José. I have also found it on the following-named plants in California: almond, quince, fig, willow, eucalyptus, acacia, and locust.

Mr. Elwood Cooper, of Santa Barbara, Cal., who has had some experience with this pest upon his olive trees, says that it is easily kept in check. According to his observations it flourished only upon those trees which are in an unhealthy condition, and as it is chiefly confined to the trunk and limbs it can be removed with a stiff brush and whale-oil soap solution.

ASPIDIOTUS TENEBRICOSUS, new species.

THE GLOOMY SCALE.

(Plate XII, Fig 5; Plate XIII, Fig. 5.)

Scale of female.—The scale of the female is very dark gray, agreeing in color with the bark to which it is attached; the protuberance indicating the position of the exuviae is marked with a white dot and concentric ring; in rubbed specimens this protuberance is smooth and black, in all cases the remainder of the surface of the scale is rough. The scale is very convex; the exuviae are usually between the center and one side. The ventral scale is well developed, especially at the margin, where it is much thickened and is dark colored; the central part is white and adheres to the bark; while the thickened margin is easily removed as a ring. Diameter of scale, 1.5^{mm} (.06 inch).

Female.—The female is nearly circular, being but slightly longer than broad; and is of a yellowish brown color. The segmentation of the body is not very distinct. The last segment presents the following characters:

Although forty-three specimens were carefully examined, no *groups of spinnerets* were found.

There are three pairs of well-developed *lobes.* The median lobes are rounded posteriorly, or often with a slight notch on the lateral margin, and taper to a point anteriorly; the second lobe of each side is somewhat triangular in outline, with the lateral edge serrate; the third lobe is larger than either the first or second lobes, triangular in outline, and serrate on lateral margin.

The posterior third of the *lateral margin of the segment* appears to be of the same structure as the lobes, and has five triangular serrate lobes; the posterior one of these is the largest, and is larger than either of the true lobes.

There are seven club-shaped *thickenings* of the body wall upon each side of the meson, which are arranged as follows: One terminating near the lateral margin of the first lobe; this extends anteriorly but a short

distance beyond the lobe. One appearing to be a prolongation of the mesal margin of the second lobe; this extends anteriorly to a point laterad with the anus. One terminating between the second and third lobes; this is linear, inconspicuous, and sometimes obsolete. One terminating at the base of the plates between the second and third lobes, and also one terminating at the base of the plates between the third lobe and the thickened lateral margin; these two are the largest, and extend anteriorly the farthest of all the thickenings: one terminating at the mesal margin of the third lobe, and one at the mesal end of the thickened lateral margin of the segment.

The *plates* between the median lobes and between the first and second lobes of each side are very small and often obsolete; there are two small irregularly-branched plates between the second spine and the third lobe, and also two similar plates between the third spine and the mesal end of the thickened lateral margin.

There are five pairs of *spines* on the ventral surface of the segment, and six on the dorsal. Those at the base of the median lobes are very small; the others are conspicuous. The second and third spines of each surface are situated just lateral of the second and third lobes respectively; in each case the dorsal spine is slightly mesad of that on the ventral surface. The fourth spine of the ventral surface is on the penultimate lobe of the thickened lateral margin. The fifth spine of this surface is near the anterior end of the thickened part of that margin. The fourth and fifth spines of the dorsal surface are in each case mesad of the corresponding spines of the ventral surface. There is also a spine on the dorsal side, very near the penultimate segment.

Eggs.—The eggs have not been observed.

Scale of male.—The scale of the male is oval in outline, and of the same color as that of the female; the protuberance covering the larval skin is near the anterior end. The ventral scale is similar to that of the female, except that the margin is not so much thickened.

Male.—Only dead and shriveled males have been observed.

Habitat.—On the bark of the trunk and limbs of red or swamp maple (*Acer rubrum*) at Washington, D. C.

Described from forty-three females and many scales of each sex.

ASPIDIOTUS UVAE, new species.

THE GRAPE SCALE.

(Plate XIV, Fig. 4; Plate XVI, Fig. 1.)

Scale of female.—The scale of the female is flat, nearly circular, with the exuviæ covered and more or less upon one side. The color of the scale is light yellowish brown, being a little lighter than the dry bark of the vine. The part of the scale covering the exuviæ is white, the latter are bright yellow. The ventral scale is thin, white, contains the ventral half of the molted skins, and adheres to the bark; so that when the insect is removed its former position is indicated by a conspicuous white spot. Diameter of scale, 1.6^{mm}.

Female.—The body of the female is nearly circular, white, with a faint yellowish tinge, and with the margin colorless and more or less transparent. The last abdominal segment presents the following characters. (See Plate XIV, fig. 4.)

There are either four or five *spinnerets;* the anterior group being either present or absent. Nineteen specimens were examined; the anterior group was represented by a single spinneret in three, by two

spinnerets in six, and was wanting in ten. The anterior laterals each consist of from four to nine spinnerets, and the posterior laterals of from three to eight.

Only one pair of lobes present; these are prominent, parallel with each other, or nearly so, and abrubtly narrowed posteriorly; the mesal constriction is a little distad of the lateral one.

There are two *incisions* of the margin of the ventral surface on each side of the meson, one laterad of the first spine, the other laterad of the second spine. The body wall bounding these incisions is conspicuously thickened.

Caudad of each incision are two *plates*, which are long and serrate on the lateral margin. Between the third and fourth spine of each side are from three to five plates; these are usually simple and equal the spines in length.

There are four pairs of *spines* on the ventral side and three on the dorsal, the first dorsal pair being obsolete. The fourth pairs are about midway between the lobes and penultimate segment.

Scale of male.—The color of the scale of the male is slightly darker than that of the scale of the female; it is elongated, with the exuviae covered, and near one extremity. The layer of excretion covering the exuviae is white. Length of scale, $.8^{mm}$; width, $.4^{mm}$.

Habitat.—On grape-vines at Vevay, Ind., received from Charles G. Boerner.

This species infests the lower part of the grape-vines, from the ground to the shoots of second year's growth. It can doubtless be easily destroyed by washing the vine with a strong solution of soap, using for this purpose a sponge.

Signoret describes* under the name of *Aspidiotus vitis* a species which infests grapes, and which, judging from his description, is very closely allied to this. It differs, however, from *A. uvæ* in that the exuviae when they have been rubbed are of a brilliant black; and the last segment of the female does not present the usual groups of pores.

Genus DIASPIS Costa.

This genus includes species of Diaspinae in which the scale of the female is more or less rounded, with the exuviae at the center or upon the side; and the scale of the male long, white, carinated, and with the larval skin at one extremity. The last segment of the female presents five groups of spinnerets.

This genus closely resembles Aspidiotus in the form of the scale of the female, but it is easily distinguished from that genus by the form of the scale of the male.

DIASPIS CARUELI Targ. Tozz.

THE JUNIPER SCALE.

[Plate V, Fig. 2; Plate XV, Fig. 3; Plate XX, Fig. 6.]

Diaspis carueli Targioni Tozzetti, Catal. (1868).

Scale of female.—The scale of the female is circular, snowy white, with the exuviae central or nearly so, naked, and yellow. Diameter of scale, 1^{mm}–1.5^{mm} (.04–.06 inch). Plate V, Fig. 2*a*.

* Annales de la Société Ent. de France, 1876, p. 603.

Female.—The females are yellow, circular in outline, a little elongated posteriorly. The last segment of the body presents the following characters:

The anterior group of *spinnerets* consists of about eight, the anterior laterals of from ten to sixteen, and the posterior laterals of about eight.

There are four *lobes* which are nearly in a straight line, the end of the body being truncate. These lobes are quite small, rounded posteriorly and are equidistant from each other. The second lobe of each side is deeply incised, but the lateral lobule is very small and in many cases concealed by the margin of the segment.

Each *lateral margin* of the segment is divided into three subequal, more or less distinct lobes; each lobe ends posteriorly in one or two lobules, each of which bears an elongated pore on its dorsal surface.

The *plates* are short and in some cases subtruncate at extremities; they are situated as follows: two between median lobes; two inconspicuous ones lateral of first lobe of each side; two lateral of second lobe; usually one on the anterior part of the first lobe of the lateral margin; one or two near the middle of the second lobe of the lateral margin, and two or three on the third or anterior lobe of the lateral margin.

The *spines* on the dorsal surface are situated as follows: one upon the first lobe near its lateral margin; one on lateral lobule of the second lobe; and one a short distance mesad of the mesal plate of each of the three lobes of the lateral margin. On the ventral surface the spine accompanying the first and second lobes of each side are obsolete. There is one at the base of the plate of the first lobe of the lateral margin; one between the plates of the second lobe, and one near the middle of the third or anterior lobe of the lateral margin.

Scale of male.—The male scale is white and very small, being only 1^{mm} (.04 inch) in length; it is elongated, with a prominent median ridge; the larval skin is naked and light yellow in color. See Fig. 2*b*.

Male.—The color of the body is light orange yellow, with the thoracic band of the same color. The terminal joints of the antennae are enlarged. For other characters, see Plate XXI, Fig. 6.

Habitat.—This species is very common in Washington, where we have found it infesting the following named species of juniper and arbor vitae: *Juniperus chinensis*, *J. rigida*, *J. oxycedrus*, *J. japonica*, *J. communis*, *J. Reresii*, *Biola orientalis*, and *Thuya occidentalis*. It was collected by Prof. Targioni Tozzetti near Florence, Italy.

DIASPIS OSTREAEFORMIS (Curtis).

THE PEAR-TREE OYSTER SCALE.

(Plate XV, Fig. 4.)

Aspidiotus ostreaeformis Ruricola, Gardiner's Chronicle, 1843. p. 803.
Aspidiotus circularis Fitch, Annual Report N. Y. State Ag. Soc., 1856, p. 426.

Scale of female.—The scale of the female is circular or broadly oval; it is of a dark ashy-gray color, with the margin lighter; sometimes the scales are nearly white. The exuviae are central or nearly so, dark brown, usually naked and glossy. Diameter 1^{mm}–1.4^{mm} (.04–.056 inch.)

Female.—The body of the female is rounded, cordate when young; the last segment presents the following characters:

The anterior group of *spinnerets* consists of eight to twelve; the anterior laterals of twelve to thirteen; posterior laterals of eight to fourteen.

The median *lobes* are large and connate, about half their length; each lobe is rounded at its distal extremity, and widened anteriorly, sometimes abruptly. On each side of the median lobes are three slight incisions in the margin of the body, approximately equidistant from each other; the margins of these incisions are thickened, and mesad of each incision there is a rudimentary lobe; there is also usually a fifth rudimentary lobe between the fifth and sixth plates.

All the *plates* excepting the first pair are well developed, thick at the base, simple, tapering, and situated at nearly equal distances throughout the entire free margin of the segment. Laterad of first lobe is a short inconspicuous plate, between which and second lobe is a prolongation of the body wall bearing an elongated pore; second plate between second and third lobes, third plate between third and fourth lobes; between fourth and fifth lobes are two plates; laterad of fifth lobe are three plates, sometimes there is a fourth next to the penultimate segment. On the penultimate segment are three or four plates, and on the antepenultimate, one or two.

The *spines* on the dorsal surface are situated as follows: on each side a short one near the meson on first lobe; a long and conspicious one laterad of same lobe; third and fourth caudad of first and second incisions; fifth laterad of third incision; and the sixth between the sixth and seventh plates. On the ventral surface the spines are smaller; first and second are obsolete, the third and fourth are laterad of the second and third incisions; and the fifth between the fourth and fifth plates.

Scale of male.—The male scales are of an elongated oval form and much flattened, especially the posterior half; a feeble carina extends along the middle, but the sides are not carinated; the larval skin is of a light brownish-yellow color, and is sometimes more than one-third the length of the whole scale; the ventral side is entirely closed, leaving only a narrow transverse slit at the posterior end; the color of the scale is white. Length 6^{mm} (.23 inch).

Male.—The male is described by Curtis as being of a bright ochreous color, with the eyes and thoracic band black.

Habitat.—This is a common species on pear and apple in England. Although I do not know of its occurrence in the United States, it will be strange if it is not found here. I am indebted to Mr. Signoret for the specimens from which this description has been prepared.

DIASPIS ROSAE (Sandberg).

THE ROSE SCALE.

(Plate V, Fig. 1, 1*a*, and 1*b*; Plate XVII, Fig. 1; Plate XXI, Fig. 5.)

Aspidiotus rosae. Sandberg (1784), Abhand Priv. Boh., No. 6, p. 317.
Diaspis rosæ. Signoret, Ann. de la Soc. Ent. de France, 1869, p. 441.

Scale of female.—The scale of the female is circular, snowy white (or, according to Signoret, yellowish white), with the exuviae light yellow, and upon one side; the first skin is naked, the second usually covered with secretion. Diameter 2^{mm}–3^{mm} (.08–.12 inch). See Plate V, Fig. 1, natural size, 1*a* enlarged.

Female.—The female is elongated, resembling in form a *Mytilaspis* more than a *Diaspis*. The head and thorax comprise the larger part of the body. The abdomen is very distinctly segmented, especially upon the sides; each segment presents one or several plates, the two seg-

ments preceding the last a greater number, but usually less than ten. The last segment presents the following characters:

The groups of *Spinnerets* are remarkable from the fact that those of each side are often more or less continuous. Signoret states that the anterior group alone is distinct; but in the majority of the specimens which I have studied the lateral groups are more or less distinct. The anterior group consists of about twenty spinnerets; the lateral group are of from twenty-five to thirty-five each. There are three pairs of lobes. The median lobes are large, slightly serrate, approximate at base, and diverging laterally. The second and third lobes of each side are deeply incised; the mesal lobule in each case is the larger.

The *plates* are long, slender, and simple; those nearer the meson are smaller than those farther removed from it; they are situated as follows: one arising from the base of the lateral margin of each of the three lobes of each side; one midway between the meson and the penultimate segment; two to four near the penultimate segment; there are commonly only two in this position, occasionally three, and sometimes four.

The *spines* on the dorsal surface are situated as follows: one very small one on each of the lobes; one on the outer lobule of each of the second and third lobes; one mesad of the fourth plate; and one between the two lateral plates. On the ventral surface there is situated a spine a little mesad of each of the first four dorsal spines.

Scale of male.—The scale of the male resembles that of other species of *Diaspis* in being long, tricarinated, white, and with the larval skin at one end. Length 1.25mm (.05 inch).

Male.—"The male is of a reddish white, with the wings white, the veins of the wings rosy; the venter is a little darker; the style equals the abdomen in length. Antennae and feet yellowish, slightly pubescent." (Signoret.)

Specimens which we bred were bright orange, with the band of the same color, and the eyes black.

Habitat.—This species infests the bark of rose bushes, and is very widely distributed both in Europe and this country. I have collected it in Florida and California, as well as in the Northern States.

From scales collected in Orange County, Florida, the adult males issued in large numbers February 22. At this date some of the females were ovipositing, and many eggs were hatching.

I have also found this species infesting raspberries and blackberries.

Genus **CHIONASPIS** Signoret.

This genus includes species of Diaspinae, in which the scale of the female is long, sometimes much widened, with the exuviae at one extremity; and the scale of the male long, generally white, more or less carinated (except in *C. ortholobis*), with the sides parallel, and the larval skin at the anterior end. The last segment of the female presents five groups of spinnerets.

This genus resembles Diaspis in the form of the scale of the male and Mytilaspis in the form of the scale of the female; in most species, however, the scale of the female is wider than in Mytilaspis.

CHIONASPIS EUONYMI, new species.

(Plate V, Fig. 3. Plate XVII, Fig. 2.)

Scale of female.—The scale of the female is of a dirty, blackish-brown color, with a gray margin; the first skin is light yellow, the second is

darker, and sometimes is but little lighter than the scale, which is not as delicate in texture as is usual in this genus; the scale, is narrow at the anterior end, and begins to widen at about the middle of the second skin and widens rapidly, so that frequently that part posterior to this skin is wider than long. There is a well-developed ventral scale consisting of a single piece, the margin of which, when it is fully formed, completely coincides with that of the dorsal scale, thus inclosing the insect in a complete shell; the two scales are attached by their lateral margins; the posterior margin, however, is free. Length of scale, 1.64^{mm} (.06 inch). Width in widest part, 1.23^{mm} (.045 inch).

Female.—The body of the female is bright orange yellow in color; the segments are very well defined; the fifth segment is the broadest; from this segment the insect tapers slowly to the anterior end of the body, and abruptly to the posterier end.

The last segment presents the following characters:

The anterior group of *spinnerets* consists of from four to six; the anterior laterals, five to eight; and the posterior laterals, two to seven, usually four.

The *lobes* are small and finely serrate; the median lobes diverge posteriorly; the second and third lobes of each side are deeply incised, each being divided into two unequal lobules, the larger of which is mesad. Mesad of each of the second and third lobes is a lobe of the unthickened body wall, which bears an elongated pore on its dorsal surface. In many cases the lateral margins of the segment are notched regularly, and each lobe thus formed bears an elongated pore on its dorsal surface.

The *plates* are slender, simple, and tapering; those on the lateral margin of the segment are the largest. There are two plates laterad of each of the first, second, and third lobes, and a pair about midway between the third lobe and the penultimate segment; sometimes in the case of this group of plates and of that laterad of the third lobe there are three or four plates instead of a single pair. The three segments preceding the last bear several (usually five or more) plates on the lateral margins. The penultimate and last segments are connate at the margin of the body.

The *spines* on the ventral surface of the segment are short and inconspicuous; there is one near the mesal member of each of the first, second, third, and fourth groups of plates. The spines on the dorsal surface are quite conspicuous with the exception of the first, which is very slender; it is situated laterad of the base of the first lobe, which it approximates in length; each of the second and third spines is near the base of the incision which divides the corresponding lobes; the fourth spine is mesad of the fourth group of plates.

Scale of male.—The scale of the male is white, tricarinate, with the exuviae light yellow. Length, 1.4^{mm} (.05–.06 inch).

Habitat.—On *Euonymus latifolia* at Norfolk, Va. The specimens were received from Mr. Henry P. Worcester, who informs me that this insect has destroyed nearly all of the shrubs of this species in that city. From the account given by Mr. Worcester it appears that only a short time elapses after the plant becomes infested before it is destroyed; but he has not observed this scale insect upon any other plant than *Euonymus*. It was, however, collected in great numbers, by Mr. Howard, upon orange trees in Louisiana, and I have received it from Havana, from which place it may have been imported to this country.

CHIONASPIS FURFURUS (Fitch).

THE SCURFY BARK LOUSE.

(Plate VI, Fig. 1; Plate XVI, Fig. 3; Plate XVII, Fig. 3.)

"Approaches *Coccus cryptogamus* Dalman" Harris, Insects injurious to vegetation, 1841, p. 203 (Flint ed. p. 254).
Aspidiotus furfurus Fitch, Report N. Y. State Ag. Soc., 1856, p. 352.
Aspidiotus cerasi Fitch, Report N. Y. State Ag. Soc., 1856, p. 368.
Coccus Harrisii, Walsh, Practical Entomologist, vol. ii, p. 31, 1866.
Aspidiotus Harrisii Walsh, Report of the acting State Entomologist of Illinois, p. 53 (1868).
Diaspis Harrisii Walsh, Signoret, Annales de la Société Entomologique de France, 1876, p. 604.

Scale of female.—The scale of the female is flat, irregular in outline, many bending abruptly to the right or left immediately posterior to the second larval skin, others straight; in all the scale suddenly widens near the posterior end of the second larval skin, thus presenting the form characteristic of the genus; length, 2^{m}–3^{mm} (.08–.12 inch); color grayish white with the first skin light gray and second skin usually brown, sometimes dark gray.

Described from many isolated individuals occurring on smooth bark of a small branch. (Fig. 1.) On the rough bark of the trunk the scales are much more irregular in form, and are so massed as to appear like a layer of dandruff.

Female.—The body of the female is red, with the last segment light yellow; this segment presents the following characters:

The anterior group of *spinnerets* consists of from eight to thirteen, usually ten; the anterior laterals are from twenty to thirty; and the posterior laterals are from eighteen to thirty-one.

There are three pairs of *lobes*. The median lobes are well developed; the second lobes are smaller, the third are still smaller, being sometimes obsolete; the lobes of the second and third pairs are deeply incised. There are conspicuous elongated pores upon the margin; one laterad of each of the first, second, third, and fourth plates; one cephalad of the incision of the third lobe; and one midway between the third and fourth plates.

The *spines* upon the ventral surface are inconspicuous; the first pair obsolete; the second, third, and fourth pairs at or near the bases of the second, third, and fourth plates. Those upon the dorsal surface are quite long; the first spine of each side is between the bases of the first lobe and the first plate; the second and third spines are upon the lateral lobule of the second and third lobes; and the fourth spine is situated about two-thirds distance from the third to the fourth plates.

Eggs.—The eggs are purplish red.

Scale of male.—The scale of the male is very small, being only $.75^{mm}$ (.03 inch) in length, narrow, usually straight and tricarinated (see Fig. 1*a*); larval skin brownish yellow, remainder of scale snowy white.

Male.—Yellow marked with irregular reddish-brown spots; thoracic band reddish brown, sometimes darker than the other markings. Length of body including style, $.62^{mm}$ (.02 inch); length of style, $.18^{mm}$ (.006 inch). On each side of the anterior part of the thorax there is a black spot which resembles an eye. Other characters represented in Fig. —.

Habitat.—Harris described it on apple and pear in Massachusetts;

Dr. Fitch found it on pear and choke cherry in New York; Walsh observed it on apple, crab, and the European mountain ash (*Sorbus aucuparia*) in Illinois; and I have found it common in apple and pear in New York, Maryland, and Southern California, and upon black cherry in Western New York.

Although this insect has been well known for many years, comparatively little has been written respecting it. This is probably due to the fact that there is another species (*Mytilaspis pomorum* Bouché), which, like this, infests the apple, and which is more common and much more destructive. The scurfy bark-louse was first described, but not named, by Harris in his "Insects Injurious to Vegetation" (Flint edition, p. 254). In this description both the scale formed by the male and that formed by the female are well characterized; but the insects themselves were not studied by Dr. Harris. The description of the scales is remarkable as containing an explanation of their nature and probable mode of formation as follows: The minute oval dark-colored scales on one of the ends of these white cases are the skins of the lice while they were in the young or larva state, and the white shells are probably formed in the same way as the down which exudes from the bodies of other bark lice, but which in these assume a regular shape, varying according to the sex and becoming membranous after it is formed." This statement must have been overlooked by Dr. Fitch, who many years afterwards, in his first report as State entomologist of New York, p. 739 (35), in writing of the oyster-shell bark louse of the apple, states that "these scales are the relics of the bodies of the gravid females, covering and protecting their eggs." And in his second report, p. 489 (257), Dr. Fitch, in describing the pine-leaf scale (*Mytilaspis pinifoliae*) states that the three parts of the scale represent seemingly the head, thorax, and abdomen of the living insect.

Through the kindness of Mr. Lintner and the officers of the New York State Agricultural Society I have had the opportunity of studying the coccidae in the collection of that society. The specimens were all labeled by Dr. Fitch, and by a very careful study of both the scale and the last segment of the female, of the specimen labeled *Aspidiotus cerasi*, I have been unable to find any character which will separate it from the specimens labeled *Aspidiotus furfurus*, and all of these specimens belong to the same species as the very common pest of the apple and pear, which has been commonly known as *Aspidiotus Harrisii*.

The statement made by Signoret* that this species is the same as that described by Curtis under the name of *Aspidiotus* (*Diaspis*) *ostreaeformis* is evidently a mistake. M. Signoret has kindly sent me specimens of *D. ostreaeformis*, from which I have prepared the description of that species in this report.

CHIONASPIS NYSSAE, new species.

THE SOUR-GUM SCALE.

(Plate XVII, Fig. 4.)

Scale of the female.—The scale of the female is snowy white, with the exuviae yellowish. It is flat, quite delicate in texture, and varies greatly in shape; it widens suddenly near the posterior end of the second skin, often becoming as wide as long; some specimens are straight, others are bent to the right or left. Length 1.5^{mm} (.05 inch).

*Annales de la Société Entom. de France, 1876, p. 604.

Female.—The last segment of the body presents the following characters:

The anterior group of *spinnerets* consists of six to eight; the anterior laterals of ten to twelve; posterior laterals eight to twelve.

The median *lobes* are large, oblong, joined at the proximal end, and widely separated at their distal extremities; the lateral margins are joined to the body, the mesal margins serrate. The second lobe of each side is incised near its lateral end, the mesal lobule being three times as large as the lateral; third lobe being obsolete.

There are four long simple *plates;* the first and second are laterad of the first and second lobes and are much longer than the lobes; the third plate is midway between the median lobe and the penultimate segment; and the fourth is near the penultimate segment.

The *spines* on the ventral surface are arranged as follows: First pair obsolete; the second, third, and fourth pairs mesad of the bases of the second, third, and fourth plates. The spines upon the dorsal surface are long and conspicuous; there are four pairs, there being a spine mesad of each plate.

Egg.—The eggs are greenish-yellow, with purplish markings.

Scale of the male.—The scale of the male is of the form characteristic of the genus, snowy white, with carinae prominent; it is relatively very long, measuring 1.25^{m} (.05 inch).

Male.—The male is greenish yellow, with the thorax and especially the thoracic band darker; eyes purplish.

Habitat.—On the black or sour gum (*Nyssa multiflora*), at Bakersville, N. C. Both male and female occur upon the leaves of the tree.

Described from eight females, thirty scales of the female, four males, and many scales of the male. I am indebted to Dr. R. S. Turner for the specimens.

CHIONASPIS ORTHOLOBIS, new species.

(Plate XVI, Fig. 6; Plate XIX, Fig. 1.)

Scale of female.—The scale of the female very closely resembles that of *C. salicis;* it is, however, smaller and narrower. Length, 2^{mm}—2.5^{mm} (about .08 inch).

Female.—The body of the female is dark purple; the last segment presents the following characters:

The anterior groups of *spinnerets* consist of from ten to sixteen; the anterior laterals of eighteen to thirty; and the posterior laterals of sixteen to twenty.

The median *lobes* are almost contiguous; their mesal margins are parallel for more than half their length; the distal margin of each is rounded.

Each of the second and third lobes is deeply incised; the lateral lobule in each case is very small, often obsolete; the mesal lobule is large and rounded; the distal margins of all the lobes are obscurely crenate.

The *plates* are as follows: One laterad of first lobe; one or two laterad of second lobe; two laterad of third lobe; and two quite large ones quite near the penultimate segment. The penultimate segment usually bears four, and the antepenultimate one.

The *spines* on the dorsal surface are as follows: The first on the base of the lateral part of first lobe; the second and third on the lateral lobule of the second and third lobes, respectively, and the fourth a short distance mesad of the lateral pair of plates. On the ventral surface there are also four on each side; each spine is laterad of the correspond-

ing spine of the dorsal surface, and cephalad of the base of the corresponding plate or group of plates.

Eggs.—The eggs are dark purple.

Scale of male.—The scale of the male differs from all other specimens of this genus known to me in not being carinated. It is an elongated oval in outline, being slightly broadest at the middle, and tapering towards both ends almost equally. The larval skin is light yellow; the scale is snowy white.

Described from thirteen males and many scales of each sex.

Habitat.—On willow, at San Bernardino, Cal. This species infests chiefly the bark of the small whip-like limbs which spring from the trunks of the trees. Many of these sprouts were dead and white with the scales of this species.

The eggs were observed September 12.

CHIONASPIS PINIFOLIAE (Fitch).

THE PINE-LEAF SCALE INSECT.

(Plate VI, Fig. 2; Plate XVI, Fig. 4; Plate XVIII, Fig. 1.)

Aspidiotus pinifoliae Fitch. Report N. Y. State Agri. Society, 1855, p. 488.
Mytilaspis pinifoliae Fitch. Le Baron, First Report State Entomologist of Illinois, p. 83.

Scale of female.—The scale of the female is snowy white in color, with the exuviae light yellow; it is usually long and narrow as represented at Fig. 2 *b*; sometimes, however, it is broad, as represented at Fig. 2 *c*. (Scale from leaf of *Pinus pallasiana.*) The shape of the scale apparently depends on that of the leaf to which it is attached. Thus on the broader-leaved pines the broad scales are more common.

Length of scale, about 3^{mm} (.1 inch).

Female.—The body of the female is purplish red; the last segment presents the following characters:

The anterior group of *spinnerets* consists of from seven to ten; the anterior laterals of twelve to twenty; and the posterior laterals of fourteen to eighteen.

The median *lobes* are somewhat circular in outline with their distal ends diverging slightly; there is an arched thickening of the body wall connecting the anterior ends of the lobes. The second and third lobes are each deeply incised; the mesal lobule is in each case the larger.

The *plates* are long, simple, tapering to a point; there is one laterad of each of the three lobes of each side, and one midway between the third lobe and the penultimate segment. There are elongated marginal pores in the following situations: One laterad of each of the first and second plates; one at the base of the mesal lobule of the third lobe; two between third and fourth plates; and two between the fourth plate and the penultimate segment.

The *spines* on the ventral surface are so delicate as to be almost invisible; their bases, however, are easily seen; they are situated one mesad of the base of each of the first, second, third, and fourth plates. The spines on the dorsal surface are quite long; the first is near the base of the first lobe, the second between the lobules of the second lobe, the third on lateral lobule of third lobe, and the fourth a short distance mesad of the fourth plate.

Scale of male.—The scale of the male is white and carinated as with other species of this genus. See Plate VI, Fig. 2*d*.

Male.—The male is a uniform orange red; eyes black.

Habitat.—On various species of pine and spruce throughout the eastern United States from New York to Florida, also pine in California.

CHIONASPIS QUERCUS, new species.

(Plate XVIII, Fig. 2.)

Scale of female.—The scale of the female is long, narrow at the anterior end, much widened posteriorly, and quite convex. The exuviae are brownish yellow; the secretion, of which the remainder of the scale is composed, is white; but all of my specimens appear dark gray, being more or less covered with the hairs of the stem to which the scale was attached and with dust. Length of scale 2mm (.08 inch).

Female.—The last segment of the female presents the following characters:

The anterior group of *spinnerets* consists of about ten; the anterior laterals of seventeen to twenty; and the posterior laterals of ten to eighteen.

This species differs from all Diaspinae known to me in having a single undivided *lobe* on the meson; this lobe is large and rounded distally. The second and third lobes of each side are very small and are laterad of small incisions in the margin of the segment. In each case there is a reniform thickening of the body wall bounding each incision anteriorly. There is also a similar incision with a rudimentary lobe and reniform thickening of the body wall about midway between third lobe and penultimate segment.

The *plates* are inconspicuous and spine-like; there are usually one or two laterad of second ventral spine; two or three between third and fourth lobe and usually five between fourth lobe and penultimate segment. The penultimate and antepenultimate segments bear six each; those on the latter are much expanded at the base.

The *spines* are long and conspicuous; those on the dorsal surface are situated as follows: One on each side at the base of the lateral margin of median lobe, one laterad of each of the second and third lobes, and a fourth one near the center of the anterior group of plates. Those on the ventral surface are as follows: A short one nearly ventrad of the first dorsal spine, a large one laterad of each of the second and third dorsal spines, and a fourth one a little cephalad of the fourth dorsal spine.

Scale of the male.—The scale of the male is snowy white, with the larval skin very light yellow. The texture of the scale is quite loose and the carinae prominent; length 1.25m (.05 inch).

Male.—The adult male is as yet unknown; many pupae were collected August 17, 1880. Specimens of these mounted in balsam are bright yellow in color, with eyes purplish black. Fully grown male larvae in balsam are yellowish brown.

Habitat.—On white oak (*Quercus lobata*) in San Fernando Valley, California. The females occur on the bark of the small limbs; the males upon the leaves.

Described from four scales of the female, four females, hundreds of scales of the male, and many male pupae and larvae.

CHIONASPIS SALICIS (Linn.)

THE WILLOW SCALE.

(Plate XVI, Fig. 5.)

Coccus salicis Linn. Syst. Nat., 741, 15.
Chionaspis salicis Signoret. Ann. de la Soc. Ent. de France, 1869, p. 447.
Chionaspis fraxini. Signoret l. c., p. 445.
Aspidiotus salicis-nigrae Walsh. Report Acting State Entomologist, Illinois (1868), p. 40.
Mytilaspis salicis Le Baron. Second Annual Report State Entomologist, Illinois (1872), p. 140.

Scale of female.—The scale of the female is of the form characteristic of the genus, being long, narrow at the anterior end, and broadly widened posteriorly. Exuviae dark yellow, normally covered by a thin layer of white excretion; this, however, is easily removed. Scale, snowy white. Length 3.4^{mm} (.13 inch), width near posterior end 1.6^{mm} (.06 inch).

Female.—The body of the female is reddish. The last segment (Plate XVI, Fig. 5) differs from that of *C. ortholobis* as follows: the median lobes are joined at the base, and are widely separated at their distal extremities; between the first plate and the second lobe and mesad of the third lobe are prolongations of the body wall, which extend caudad as far as the lobes, and bear elongated pores. Immediately laterad of the third group of plates is a prominent prolongation of the body bearing an elongated pore, while in the case of *C. ortholobis* this is situated at one-third the distance from the third to the fourth group of plates. In *C. Salicis* the two lateral groups of plates often consist of three instead of two; and the penultimate segment bears at least 6 plates; the antepenultimate three or four, and the one anterior to this, one or two.

Scale of male.—The scale of the male is long, narrow, with the sides nearly parallel. It is tricarinated and snowy white, with the exuviae yellowish.

Habitat.—Infesting willow and ash in Europe and in the United States.

Specimens of "*Chionaspis fraxini*" received from England are identical with *Chionaspis salicis* received from *M. Signoret*. I have also received this species from Ithaca, N. Y., and from Saint Louis, Mo., in each case upon willow.

Genus **MYTILASPIS** (Targ. Tozz.).

This genus includes the species of Diaspinae in which the scale is long, narrow, more or less curved, and with the exuviae at the anterior extremity. The scale of the male resembles that of the female in form; but it can be readily distinguished by its small size, and by bearing only one larval skin.

In all the species of Mytilaspis which I have studied the posterior part (about one-fourth) of the scale of the male is joined to the remainder by a thin portion which serves as a hinge, allowing the posterior part to be lifted when the male emerges.

MYTILASPIS CITRICOLA (Packard).

(Plate VII, Fig. 1; Plate XX, Fig 3; Plate XVIII, Fig. 3.)

Aspidiotus citricola Packard. Guide to the Study of Insects, second edition (1870), p. 527.*

Scale of female.—The scale of the female is long, more or less curved, and widened posteriorly. It is brown with the exuviae of the same color and with a delicate margin (Fig. 1*a*). The ventral scale is well developed; it is white, and consists of a single piece which is slightly attached at its sides to the lower edge of the scale, and is more or less incomplete posteriorly (Fig. 1*b*). Length of scale, 3^{mm} (.12 inch).

Female.—The female is yellowish white. The characters of the last segment are as follows:

The anterior group of *spinnerets* consists of about six; the anterior laterals of about eighteen, and the posterior laterals of about nine.

The median *lobes* are well developed with the margins crenate; the second lobe deeply incised, with the margins of the lobules either entire or crenate; the third lobe is quite inconspicuous, projecting but little beyond the body wall, the margin crenate and one large notch in the center of the lobe.

The *plates* are long, simple, and tapering. There are two of them in each of the following places: between median lobes; between first and second lobes; between second and third lobes; laterad of third lobe; and about midway between this lobe and the penultimate segment. There is an elongated pore between first and second lobes; two laterad of each of the third and fourth pairs of plates; and one laterad of the fifth pair of plates. The penultimate segment bears at least four plates upon each lateral margin.

The *spines* upon the dorsal surface are long, and are situated as follows: one at the base of each margin of the first lobe; one dorsad of incision of second lobe; one dorsad of the notch of third lobe; and one about midway between the fourth and fifth pairs of plates. Those of the ventral surface are as follows: cephalad of the bases of the first pair of plates are two small spots which resemble the bases of spines, and are doubtless the homologues of the first pair; the second spine of each side is near the base of the lateral half of the first lobe; third spine laterad of lateral lobule of second lobe and fourth and fifth spines between the members of the fourth and fifth pairs of plates respectively.

Eggs.—The eggs are white and are arranged irregularly under the scale.

Scale of male.—The scale of the male is usually straight, or nearly so; the same color as that of the female, or in some specimens varying to a very dark brown, almost black, the larval skin light yellow. At about one-quarter of the length of the scale from the posterior extremity, the scale is thin, forming a hinge which allows the posterior part of it to be lifted by the male as he emerges. Length, 1.5^{mm} (.06 inch).

*The descriptions of *Aspidiotus Gloverii* and of *Aspidiotus citricola* given by Packard in his guide to the study of insects, p. 527, are not only unrecognizable *per se*, but are merely descriptions of unpublished figures, and consequently have no claim to recognition. But a desire to prevent confusion has led me to adopt these specific names. I have had no hesitation in doing this, because a very careful search which I have made of many orange groves in Florida has revealed the fact that there are only two species of Mytilaspis common on citrus trees in that State, and consequently there can be but little doubt that they are the species which Professor Glover figured. To the form with the narrower scale I apply the name *Gloverii*, to the other that of *citricola*.

Development of the insect and formation of the scale.—Upon March 15, 1880, observations were commenced upon a brood of young lice just hatching. Their color was white, yellowish at both ends, and with red eyes; antennae 6 jointed; margin of the head as far as the eyes tubercled, and each segment of the abdomen with a lateral piliferous tubercle. When placed upon a young orange tree, all settled in from fifteen to twenty minutes. Twenty-four hours later no change had taken place except that the cottony excretion referred to in the general remarks was already observable at the posterior end of the body. Forty-eight hours from the time of hatching the cottony mass had increased to such an extent that only the anterior fourth of the larva could be seen. The secretion was dense and compact, and a few long, very fine, rather curly threads of a yellowish color protruded from it. Each side of the head a fine curl of the cottony substance extended forward and, from the frontal border of the head, filaments of the same extended at equal distances. At seventy-two hours the dense excretion had covered the eyes. Behind the head in most specimens there was a marked constriction in the covering, which in some, however, was but slightly indicated.

From this period up to the age of ten days the alteration was but slight. The covering had increased so as to extend beyond the head of the insect. Removing the covering, it was noticed that nearly all trace of the segmentation of the abdomen was gone, and that it was oval in form. Upon abdominal joints 1, 2, 3, and 4, four rows (two dorsal and two lateral) of pale transparent spots were noticed. From this time (March 25) on until April 6, the changes in the body of the insect were very slight. The skin was gradually separating from the body within, and toward the latter part of this period the abdominal outline of the latter with its notches could be plainly seen through the first larval skin. April 6, or twenty-two days from hatching, the larvae molted their first skin. In preparation for this act they worked their way partly out of their excreted cases, sometimes destroying the anterior end in the effort. In the act of molting the skin splits ventro-transversely between the thorax and the abdomen, and the abdomen is first drawn forward and thrust through the aperture. How the remainder of the body is disengaged is not precisely known—whether it is drawn down through the same split, or whether the anterior part of the old skin has a longitudinal ventral split—but the latter is probably the case. The color of the insect after this first molt is white with pale orange eyes and a tinge of yellow to the proboscis, to the alimentary canal, and to the end of the body. Great irregularity was noticed in the time of shedding of the skin, some finishing two weeks before others, and after the molt was completed some were covered entirely and hidden from view by the cast-off skin and waxy secretion; while others were partly exposed. The old covering began to melt gradually and the new scale began to form at the posterior end of the body, at first resembling compact scum or froth, and six days after the molt it was already from three to four times the size of the shed skin which adheres to the outside of the forming scale, covered as to its anterior half by the remains of the woolly secretion of first stage.

From this time on till forty days from the time of hatching the scale grew gradually as also the inclosed insect, the former at this time changing from white to yellowish brown, having precisely the appearance of the full-grown scale except as to size. At forty-four days after hatching, the scales were about one-fourth the size of the full grown. At forty-six days it was observed that the male larvae were rapidly maturing and that already traces of antennae and legs were to be seen. At fifty-four

days the more advanced individuals shed the second skin and appeared as pupae. About the same time the females also cast their second skin. Our notes do not show the exact length of time which the males remained in the pupa state, but that it is very short is shown by the fact that on May 18 pupae from eggs hatched March 30 were observed to transform to adults, the old pupa skin being pushed backward out of the scale. The description of the adults of both sexes has already been given.

At eighty days the females were observed to have deposited eggs and already the young had begun to hatch. Later in the season the development is more rapid than that just detailed. From eggs which hatched May 22, males were reared June 25, a space of thirty-four days, while the females of the same generation had begun to oviposit July 12, or fifty-one days from hatching.

Habitat.—This is one of the two most common species of scale insects found on citrus trees in Florida. It is probably an European species, as I have frequently found it on imported oranges in our market. It also occurs in Louisiana. Mr. Glover states (Report Department of Agriculture, 1855, p. 119) that this species was imported into Jacksonville, Fla., in 1855, on some lemons sent from Bermuda.

MYTILASPIS GLOVERII (Packard).

GLOVER'S SCALE.

(Plate VII, Fig. 2; Plate XVIII, Fig. 4; Plate XXI, Fig. 1.)

Coccus Gloverii (Packard). Guide to the Study of Insects (1869), p. 527.
Aspidiotus Gloverii (Packard). Ibid. second edition (1870), p. 527.
Mytilaspis Gloverii (Packard). Ashmead Orange Insects (1880), p. 1.

The scale of female. The scale of the female in this species differs from that of *M. citricola*, with which its often associated, in being much narrower (Plate VII, fig. 2, natural size; 2 *a*, enlarged). Color light yellow, varying to dark brown; the ventral scale is white and consists of two long narrow parallel plates between which is an open space (Plate VII, fig. 2 *c*).

Female.—The body of the female is light purple in color, with the last segment yellowish; this segment presents the following characters:

The anterior group of *spinnerets* consists of five; the anterior laterals about eleven, and the posterior laterals of five.

The margin of the segment is the same as in *M. citricola* with the following exceptions: the first lobe on each side is abruptly narrow, then prolonged more or less into a point, with the margins scarcely serrate; lobules of second lobe longer and narrower.

The *spines* are very small; the ventral one on the median lobe invisible. There are only two plates on the penultimate segment.

Eggs.—The eggs are white when first laid, but become tinged with purple before hatching. They are arranged in two rows in a very regular manner. (Plate VII, Fig. 2, *c*.)

Scale of male.—The scale of the male is similar in form to that of the female, except that there is but a single molted skin, and the scale is furnished with a hinge like that described under head of *M. citrocola.*

Male.—For figure of male see Plate XXI, Fig. 1.

Development of the insect and formation of the scale.—Our observations show that the development of Glover's scale is up to a certain point almost parallel with that of *M. citricola*, and that its failure at that point may be abnormal will be seen from what follows. March 27, eggs under

observation began to hatch. The young larvae are purplish, with the front of the head and the margin of the body yellowish. Most of them settled almost immediately, and at two days the cottony excretion had covered one-half the insect. At four days it reached beyond the eyes, and the larva itself seemed to be more elongated, with the joints more distinct. At six days most of them were entirely covered, with the excretion extending like two horns at each side of the head. With some there were only two or three transverse constrictions of the covering, giving them a very peculiar appearance. At seven days the future dentate appearance of the abdomen could already be detected through the skin, and at eleven several presented every appearance of a speedy molt, having pushed themselves forward from the covering. They remained in this state, however, without marked change, except that some secreted a tuft of the waxy threads, which rose erect for two or three times the length of the scale, for twelve days more before shedding their first skin, which was done at the age of twenty-three days. The molt was performed in precisely the same manner as with citricola. Immediately after the molt the whitish permanent scale began to form. At thirty-two days one could begin to distinguish the legs and antennae of the future pupae in the males. At forty-four days the first female was observed to have cast its second skin; the color after the molt is white, with the anal segment and middle of the body yellowish. About the same time the males became pupae, and at forty-five days the first adult male was found. From this time up to the age of one hundred and two days the female scales were watched daily, but no eggs were observed. At this age all either died or were mounted, so the age at which the eggs are deposited has not been determined. It may be that the non-development in this case was due to the fact that the females had not been fertilized.

Habitat.—This is a very common species on citrus trees in Florida and Louisiana. It infests the fruit, leaves, and bark of the trees, and is usually associated with *M. citricola*. It is supposed that it was introduced into Florida about forty years ago by Mr. H. B. Robinson, who owned a grove at Mandarin. Mr. Robinson is said to have purchased two trees in New York from a ship from China. From these trees the insect is said to have spread.*

Trees which this department received from Europe were badly infested by this scale insect. This, however, does not prove the European origin of the pest, as it may have been carried there from China.

MYTILASPIS? PANDANNI, new species.

(Plate XX, Figs. 1 and 2.)

Scale of female.—The scale of the female is light brown in color, with the posterior end paler and sometimes white; the first larval skin is naked; the second, which is large, is covered with excretion. The shape varies greatly. Some specimens broaden gradually from the first larval skin to near the posterior end; in some the lateral margins are more or less curved, so that the scale is broadest at or near the middle; others are suddenly widened near the middle of the second larval skin.

Females.—The body of the female is yellowish; the last segment presents the following characters:

The anterior group of *spinnerets* consist of four; the anterior laterals of nine or ten; the posterior laterals of ten to twelve.

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* See Glover, Report Department of Agriculture, 1855, p. 117.

There are two pairs of *lobes*; each lobe is small; the mesal margins of the median lobes are parallel; between these lobes is an incision extending cephalad of base of lobes for a distance equal to one-half of length of lobes. The second lobe of each side is deeply incised; the mesal lobule is the largest and longest.

The *plates* are simple, tapering, and longer than the lobes. There is one laterad of each of the lobes; one a little less than half the distance from the first lobe to penultimate segment; and one near the latter. The penultimate segment usually bears two and the antepenultimate one.

The *spines* on the dorsal surface are quite long, and are situated as follows: first, laterad of first lobe; second, upon the lateral lobule of second lobe; third, at about two-thirds the distance from second to third plates; and fourth, at two-thirds the distance from third plate to fourth plate.

Between the first plate and mesal lobule of second lobe is a projection of the body as long as the latter, which bears an elongated pore.

Described from fourteen females and many scales.

Habitat.—This species was collected by Mr. Trelease, upon Pandanus, in the Harvard Botanic Garden, at Cambridge, Mass.

The scale of this insect varies greatly from the typical form of Mytilaspis. The species is evidently closely allied to the *M.? buxi* (Bouché) as described by Signoret.

MYTILASPIS POMORUM (Bouché).

THE OYSTER-SHELL BARK-LOUSE OF THE APPLE.

(Plate XIX, Fig. 2.)

Aspidiotus pomorum Bouché. Ent. Zeitung Stett. (1851), XII., No. 1.
Aspidiotus conchiformis of Authors; but not *A. conchiformis* Gmélin Syst. Nat., 2221, 37 (1788), which species infests elm.
Aspidiotus pyrus-malus Rob. Kennicott (1854), Acad. Science of Cleveland.
Mytilaspis pomicorticis Riley. Fifth Report State Entomologist Missouri, p. 95.
Mytilaspis pomorum (Bouché). Signoret, Ann. de la Soc. Ent. de France, 1870, p. 98.

Scale of female.—The scale of the female is long, narrow, widened posteriorly, more or less curved, of an ash gray color with the exuviae yellowish. Length, 2^{mm} (.08 inch).

Female.—The body of the female is yellowish white. The last segment presents the following characters:

The anterior group of *spinnerets* consists of from eleven to seventeen; the anterior laterals and posterior laterals each of sixteen to twenty-one.

The median *lobes* are large and wide, with the sides parallel; they are only about three-fourths as long as broad; each lobe is narrowed on each side near the distal extremity by one or two notches and then rounded. The second lobe of each side is about as wide as the first, and is deeply incised; mesal lobule with mesal margin as long as lateral margin of the first lobe, and rounded posteriorly; lateral lobule about half the length and width of mesal lobule and similar in shape. Third lobe obsolete.

The plates are arranged as in *M. citricola*; the lateral members of the second and third pairs are shorter and smaller than the mesal. The penultimate segment bears two pairs on each side.

The spines are as in *M. citricola* except that the first dorsal pair are not so conspicuous.

Scale of male.—The scale of the male of this species closely resembles those of *M. Gloverii* and *M. citricola*, being much smaller than that of

the female, straight or nearly so, with a single molted skin, and with the posterior part joined to the remainder of the scale by a thin portion which serves as a hinge.

Male.—I have not bred the male from apple. Its color is described by Riley* as being translucent corneous-gray with a dorsal transverse band on each joint, and the portions of the mesothorax and metathorax darker or purple gray, and with the members somewhat lighter.

Habitat.—This is an imported European species, which is common throughout the greater part of those sections of the United States where apples are grown to any great extent. It is, however, much more common in the cooler parts of the country, being replaced to a certain extent by *Chionaspis furfurus* in the warmer sections.

There is but a single generation of this insect each year in the North, where the eggs hatch in the latter part of May, or early in June, and two generations in the South.

This species is said to infest many different plants; but in nearly if not every case the opinion respecting the specific identity of the forms occurring on other plants with that upon apple has been based upon the characters presented by the scale. These characters being insufficient to distinguish this species from closely allied forms, it is very desirable to confirm these observations. I have, however, found about twenty different species of plants infested by one or more species of Mytilaspis, which, after the most careful study of structural characters, I am unable to distinguish from *M. pomorum.* The greater part of these plants are trees growing in the parks and along the streets of Washington; and if the scale with which they are infested is *M. pomorum*, it is a very remarkable fact that, notwithstanding the abundance of it on these trees, apple trees growing in the immediate vicinity are not infested, and, too, although the male of *M. pomorum* is rare on apple, it is not at all so on the other plants. The following is a list of the plants upon which I have found this form of Mytilaspis: linden, hop-tree, bladder-nut, horse chestnut, maple, an exotic Amorpha, water-locust, raspberry, hawthorn, currant, *Ribes alpenum*, *Lonicera pulverulenta*, ash, elm, hackberry, *Planera kakii*, willow, poplar, and *Yucca*

Genus **PARLATORIA** Targioni-Tozzetti.

The following are the characters of this genus as given by Signoret:

"Species of which the scale of the female is long, narrow at the base, then enlarging suddenly; the exuviae of a rounded oval form." "Four groups of pores only."

"The margin of the anal segment is indented and presents in each notch some plate-like scales." "On the upper side near the margin two rows of isolated pores." "The scale of the male of the same color as that of the female and much smaller."

Only two species of this genus have been described: *P. proteus* Curtis and *P. zizyphi* Lucas; I add a description of a third. A comparative study of *P. zizyphi*, *P. pergandii*, and two undescribed species in the collection of the department shows that there is very little variation in the *number* of the appendages of the last segment of the female; specific characters are to be found in the *shape* of these organs, and the *position* of the spines. I have not seen *P. proteus.*

*Fifth Missouri Report, p. 95.

PARLATORIA PERGANDII, new species.

PERGANDE'S SCALE.

(Plate XI, Fig. 4; Plate XX, Fig. 5.)

Scale of female.—The scale of the female varies in form; sometimes it is nearly circular in outline, with the exuviae upon one side; usually, however, it is somewhat elongated, with the exuviae at one end; color of scale, dirty gray; the first skin is naked; the second is covered with a very thin film of secretion, and occupies about one-third of the length of the scale; length of scale, 1.6^{mm} (.06 inch).

Female.—The female is nearly as broad as long, and varies greatly in color; some specimens are almost entirely white, with only the end of the body slightly yellow; others are entirely yellow, and some are purplish, with the posterior end of the body yellow; eyes black. The last segment presents the following characters:

There are only four groups of *spinnerets*, each usually consisting of eight or nine; but the number in each group varies from four to ten.

There are three pairs of well-developed *lobes;* each lobe is widest near the middle, tapering anteriorly, and suddenly narrowed posteriorly. There is a fourth rudimentary lobe upon each side about midway between the third lobe and the penultimate segment; this lobe is irregularly rounded and produced into a papilla at its distal extremity; there is a similar lobe on the penultimate segment, cephalad of the posterior plate of that segment. Connecting the bases of the lobes are crescent-shaped thickenings of the body wall, which are in reality the thickened margins of elongated pores placed at right angles to the median line of the body. There is one of these pores in each of the following places: between median lobes; between median and second lobes; between second and third lobes; and there are two between third and fourth lobes; also two between fourth lobes and the penultimate segment.

There are two *plates* between the median lobes; two between first and second lobes; and three between second and third lobes. These are similar in shape, and in each case extend caudad as far as the tips of the lobes. Each plate is oblong, with the sides parallel and with the distal extremity fringed. Between the third and fourth lobes are three plates varying in shape from the form just described to palmate; the middle member of this group is usually as large as the other two combined. The three plates cephalad of the fourth lobe are usually palmate.* The three segments preceding the last usually have five or six plates each, on each lateral margin; these plates are rounded and produced into a single papilla at the distal extremity. The fourth segment preceding the last often bears one or two plates also.

Each lobe bears a *spine* on its dorsal surface; that of the fourth lobe is situated near the center of the lobe; each of the others is near the lateral margin of the base of its lobe. The spines on the ventral surface (except the first, which is obsolete) are longer and more conspicuous; the second, third, and fourth are each situated dorsad of the lateral margin of the first plate, laterad of the second, third, and fourth lobes, respectively. Each of the three segments preceding the last bears a conspicuous spine near the middle of each lateral margin.

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*In the most closely allied of the described species—*Parlatoria proteus* Curtis—the plates of the last segment according to the figures and description of Signoret have a different form, being smooth on the mesal margin and serrate on the lateral.

Eggs.—The eggs and young larvae are purplish. Twenty-seven eggs were observed under one scale; but in another instance the abdomen of a female was more than half filled by five eggs.

Scale of the male.—The scale of the male is long and narrow; the larval skin is at the anterior end, and occupies a little more than one-third of the length of the scale; the lateral margins of the scale are prominent; the central part is not carinated and is very seldom higher than the sides; usually, and especially with old scales, after the adult has emerged the central part is depressed, giving that part of the scale posterior to the larval skin the form of a gutter.

The larval skin is grayish yellow, with the central part a very dark green; the excretion is light gray; length of scale, 1^{mm} (.04 inch).

Male.—The male is purplish in color, with the disk of the thorax nearly colorless, with the exception of some irregular purplish spots, and the sutures, which are brownish; the eyes are large and very dark. (See Plate XXI, Fig. 8.)

Habitat.—This species infests the trunk, leaves, and fruit of the citrus trees in Florida. It occurs more abundantly on the bark of the small imbs than on any other part of the tree; occasionally, however, it very hickly infests the fruit. Frequently it may be found on Florida oranges n the Northern markets, but I have never observed it on imported fruit. And as I have not yet found it infesting native plants I can offer no uggestions as to whence it came. The scales so closely resemble the bark in color that a tree may become very badly infested before attracting attention.

Number of generations per year.—The length of time occupied by a generation of this species varies greatly, according to the season of the year. Thus we observed that in a brood which hatched March 31 the larvae began to molt on the twenty-second day; the first male pupa was observed on the forty-second day; the second molt of the females began on the forty-fifth day; the first adult males were observed on the forty-ninth day; and the females did not begin to oviposit until they were more than two months old. In another brood which hatched April 26 there were developed females which began to oviposit on the forty-fifth day. And the females of still another brood which hatched June 23 began to oviposit when only forty-one days old. These observations were made in the breeding-room of this department in Washington. In the open air in Florida the periods are probably even shorter.

It gives me great pleasure to dedicate this important species to Mr. Th. Pergande, whose patient labors, although but little known to the public, have done much to advance economic entomology.

FIORINIA. Targioni-Tozzetti.

~~This genus~~ includes species of Diaspinae, in which upon the scale of the female only one larval skin is visible at the anterior extremity; the second skin is present, but it is entirely covered by secretion. This skin is large, covering the insect entirely. The scale is narrow at its anterior end; it soon widens, and the sides are parallel throughout the greater part of its length. The three anterior groups of *spinnerets* are united, forming a continuous line.

The scale of the male is similar to that of the female, but smaller.

Only one species of this genus has been described heretofore—the *Fiorinia pellucida* of Targioni-Tozzetti—which is said to be common on many plants in hot-houses, and especially upon *Areca aurea* and *Phytelephas macrocarpa*. As yet this species has not been reported from

this country. We have, however, a very pernicious pest which belongs to this genus, and of which I offer the following description:

FIORINIA CAMELLIAE, new species.

(Plate XI, Fig. 7, scale; Plate XIX, Fig. 4, ♀.)

Scale of the female.—The scale of the female is yellowish brown, with the larval skin yellow, and a thin margin to the remainder of the scale white. That part of the scale which covers the second skin has a prominent, longitudinal, central ridge, which is dark brown; the sides of the scale sloping from this ridge are more or less wrinkled.

Female.—The fully-grown female is of a pale yellowish brown color, with large irregular lemon-yellow spots. The last segment presents the following characters (Plate XIX, Fig. 4, and Plate XX, Fig. 4):

The anterior group of *spinnerets* consists of about nine, arranged in a single row; the anterior laterals of about nine each, usually in a double row, and continuous with the anterior group; and the posterior laterals of about sixteen, arranged more or less regularly in a double row.

There are only two pairs of *lobes* present, and their margins are conspicuously serrate. The caudal extremity of the segment is deeply notched, and the first pair of lobes is borne by the margins of this notch. The second lobe of each side is deeply incised; the median lobule is the larger.

The *plates* are simple, slender, tapering, and extend caudad of the lobes; there is one laterad of each lobe, and sometimes one on the lateral margin of the segment.

There is an elongated *pore* laterad of each of the first and second plates; one nearly midway from the end of the body to the penultimate segment, and one near that segment.

There is a pair of *spines* between the median lobes, which appear to be neither ventral nor dorsal. The spines on the dorsal surface are as follows:* one delicate one laterad of anterior portion of first lobe; a larger one posterior to it at the base of the first plate; a large one on the lateral lobule of second lobe; a similar one about midway between the second and third pores, and also one between the third and fourth pores. On the ventral surface there are only three spines on each side: one at the base of the second plate, and one laterad of each of the two lateral spines of the dorsal surface.

Eggs.—The eggs and young larvae are lemon-yellow.

Habitat.—This is a very troublesome pest of the *camelia* in the conservatories of this department. It also infests a palm (*Kentia balmoriana*) and *Cycus revoluta*.

Genus **ASTERODIASPIS** Signoret.

The females of this genus resemble those of *Asterolecanium* Targ.-Tozz. Around the lateral edge and upon the dorsum are *spinnerets*, which secrete a fringe which persists upon the sides but which upon the back melts down and forms a continuous whole, which constitutes in the old individuals a hard and consistent shield, slightly irridescent, which covers the whole insect. When the females have deposited their eggs, the body shrinks up into the cephalic end of the covering so that

* Note that the figure of the margin of this segment (Plate XIX, Fig. 4) represents the *dorsal* surface. In all other cases in this report the figures of the last segment represent the *ventral* surface.

there appears to be only a sac inclosing the eggs, which one would naturally take to be the body of the female. The male scale is of a long oval, with a weak median carina, and showing under the microscope an elegant fringe around the edge similar to that of the female scale.

ASTERODIASPIS QUERCICOLA (Bouché).

Adult female.—Of a dark brown or a clear yellow color, nearly round in outline, furnished at the anal extremity with a rounded lobule and above with transverse striae, which represent the abdominal segmentation. Diameter from 1^{mm} to 2^{mm}.

The skin is covered with quite a large number of tubular *spinnerets.* The circumference of the body is ciliated with a fine radiating fringe secreted by openings upon the edge of the body. This fringe is double, formed of a row of large tubes joined together two by two, secreted by double openings, and another row, smaller, secreted by smaller openings placed below the others.

These insects are very closely applied to the bark, forming for themselves, in fact, slight depressions, so that it is very difficult to lift them. Occasionally, however, one of the yellow scales (in which the body of the insect has shrunken up to the end) is slightly elevated at one side, perhaps to allow for the exit of the young. On lifting one of the scales there remain upon the bark floury marks corresponding to the stigmata.

Male.—The male scale is of a long oval, 1^{mm} in length by 0.6^{mm} in width; of a clear brilliant yellow with a weak median carina, and with a fringe similar to that of the female.

The male is brownish yellow upon the head and thorax, and of a clearer yellow upon the abdomen, the base of which is a little darker; the antennae and legs almost black, the prothorax and mesothorax darker than the rest, the transverse band of the metathorax perfectly black as well as the eyes. The wings are large and of a transparent whitish gray. The abdomen is large and rounded; the stylet is dark yellow and $.35^{mm}$ long.

Habitat.—Upon the imported oaks on the Department of Agriculture grounds at Washington. Only the females were found and the male description is taken from Signoret. The species is not a common one in Europe, but is occasionally quite destructive to an individual tree.

SUB-FAMILY LECANINAE.

Genus CEROPLASTES.

The species belonging to this genus are furnished with a thick covering of waxy material, which does not, however, adhere closely to the insect. This covering is formed of layers secreted by the spinnerets. Some of the species have tuberosities upon the back which are larger or smaller according to the age of the insect, and which entirely disappear at full growth, when, from being more or less flat with tuberosities or nuclei with concentric lines, they become smooth and globular. The antennae are 6-jointed, the 3d being the longest. (In the larva state the 4th and 5th appear as one.) The legs are long. The claw is furnished with four digitules, of which the two shortest are very large and horn-shaped.

The male of this genus is not known.

CEROPLASTES FLORIDENSIS, new species.

THE FLORIDA CEROPLASTES.

(Plate IV, Fig. 2.)

Adult female.—Subglobular in form, the point of attachment to the twig or leaf being concave. Length from 2.5^{mm} to 3^{mm}. Color, when naked, reddish brown; covered with an apparently homogeneous layer of waxy excretion, which is usually brownish on the dorsum and dirty white towards the edges; some specimens are irregularly mottled brownish and yellow white. Antennae 6-jointed, joint 3 nearly as long as all the others together. Legs normal in all respects. The margin of the body in the region of the stigmata is furnished with groups of minute arrow-shaped tubercles, constricted at the base, and between these groups bristle-shaped spinnerets. (We doubt whether these arrow-shaped tubercles will prove of specific value, but they are only mentioned by Signoret in two species, *C. Vinsonii* and *C. Fairmairii*, in the former case accompanied by the bristles, in the latter without them.)

The egg.—Ellipsoidal in form; 0.25^{mm} long and about half as wide. Color, light reddish brown.

The newly-hatched larva.—Moderately slender; antennae 6-jointed, joint 6 furnished with a number of very long hairs. Tarsi as long as tibiae; the two digitules of the claw are slender and but slightly expanded at the tip; of the other two tarsal digitules, the distal one is very short and slender and with but a very slight expansion, while the proximal is long and stout and has the normal appearance. The two bristles of the pre-caudal lobes are very long, while those of the caudal lobes are very short. The color is light reddish brown, with slightly paler legs and antennae.

Growth of the insect.—The young lice are very active, and upon hatching spread at once in all directions, settling usually in from one-half to three-quarters of an hour, and usually upon the upper surface of the leaf near the mid-rib. While engaged in inserting the proboscis into the leaf the legs and antennae are all in motion, but once fixed they are all drawn under the body, and the insect appears motionless and memberless. At two days after hatching, two parallel dorsal ridges of white secretion, meeting in front and behind and dentate along the inner edges, made their appearance.* At three days these ridges were plainer, divided transversely at the middle, and some of the inner dentations had grown so as to touch those of the opposite side. Around the subdorsal portion were bits of white secretion, apparently eight on each side, one behind each eye, and a larger one between the eyes. At five days the subdorsal spots had increased in size, especially the one between the eyes, and the first, second, and fourth thoracic pairs and the seventh and eighth abdominal pairs. (There are now seen to be four thoracic and eight abdominal pairs of these spots in addition to the large one between the eyes.) The dorsal secretion at this time forms almost two compact masses, leaving only a very narrow line through which the body is still to be seen. At six days the dorsal secretion had become entirely united, and the tufts, as we may now call them, increased in length, the first abdominal pair being shortest and the others towards

*The periods given here are as noticed in a cool breeding-room at Washington; in Florida they are probably shorter.

the anal end gradually increasing in size. At nineteen days the dorsal secretion had formed a compact oval mass, and there were fifteen distinct lateral tufts to be seen, seven on each side and one at the point. At this stage all the specimens which we have attempted to rear have died. Many lived for months without perceptible change, and the conditions are probably not favorable for the production of further secretion or for the change of the white tufts into the waxy plates which are seen in the next stage of growth.

When the insect has attained a length of from 1.5^{mm} to 2^{mm}, it is found to be covered with nine irregular waxy plates, the central one very small and the six lateral ones larger, of an irregular oval in shape, while the cephalic and caudal ones are triangular, the apex of the triangle towards the central plate. Near the center of each of these plates is usually a small bit of the white secretion (usually larger with the central plate than any other). The plates are even at this time not well differentiated, and, with the increase of the insect in size, the dividing lines become lost, the lateral plates extend over the central, until at full growth the wax presents the appearance of a continuous, even covering. At any time previous to full growth, after the plates have been formed, if the waxy shield be removed, six very large prominences will be observed, three on each side of the insect, corresponding to the six original lateral plates. As the body fills with eggs and expands, these tuberosities grow less perceptible, until in the old female they are not to be seen at all.

The half-grown specimens are usually dirty yellowish white in color, often tinted with pinkish or reddish brown.

Food plants.—While the principal economic importance of this species is derived from the fact that it is to be found upon all the different citrus plants in different parts of Florida, yet it is also found upon fig, pomegranate, guava, tea (?), quince, and Japan plum (*Biotrites Japonica*). I have also found it upon red bay, oleander, sweet bay, very abundantly upon the gall berry (*Ilex glaber*), upon the common myrtle, and upon an ericaceous plant belonging to the genus *Andromeda*.

Synonymical.—This species is treated under the name of *Ceroplastes rusci* Linn. by Mr. Ashmead in his "Orange Insects," and what is probably the same insect was similarly identified by Professor Riley in the Department of Agriculture report for 1878, p. 208. Compared with *C. rusci*, however, *C. Floridensis* presents several marked differences, the most easily noticeable being the small size of the central plate and its entire disappearance so early in the life of the insect. With *C. rusci*, according to the figures of Targioni and Signoret, the central plate is much larger than any of the others, and continues so as long as any dividing lines can be observed.

From the specific name which I have given this insect it will be seen that I consider it indigenous. I found it common in all parts of Florida which I visited, even upon the pine barrens, many miles from any orange grove. Moreover, I have always found it more abundant upon the gall-berry than upon the orange or any cultivated plant. Mr. Ashmead considers it as imported, but his specific identification has undoubtedly misled him.

The orange-growers cannot expect to free their groves from this insect so long as the gall-berry grows about them as abundantly as it does in some places. I have always found those bushes growing in wet places more extensively infested than others.

CEROPLASTES CIRRIPEDIFORMIS, new species.

THE BARNACLE SCALE.

(Plate IV, Fig. 3.)

Adult female.—Average length 5^{mm}; width, 4^{mm}; height, 4^{mm}. When naked the color is dark reddish brown; the shape sub-globular, with a strong spine-like projection at the anal end of the body. The waxy covering is dirty white, mottled with several shades of grayish or light brown, and even in the oldest specimens retains the division into plates, although the form is more rounded and the dividing lines by no means as distinct as at an earlier age. There are visible a large convex dorsal plate, and apparently six lateral, each with a central nucleus; the anal plate, however, is larger, and shows two nuclei, and is evidently two plates joined together. Antennae 6-jointed, and proportioned as with *C. Floridensis*. Legs long; tibiae nearly twice as long as tarsi; digitules of the claw very large. The other tarsal pair very long and slender, but with a very large button. The skin is seen in places to be furnished with many minute, round, transparent cellules, probably *spinnerets* (indicated and so called by Signoret in his description of *C. Vinsonii*), and along the border are small groups of the constricted arrow-shaped tubercles mentioned in the last species; but the bristle-shaped *spinnerets* seem to be wanting, as in *C. Fairmairii* Targ.

The eggs.—Length 0.35^{mm}, rather slender, little more than a third as thick as long. Color light reddish brown, rather darker than the egg of *C. Floridensis*.

Young larva.—Very slender; dark brown in color; legs and antennae as with *C. Floridensis*.

Growth of the insect.—The growth of the insect and the formation of the waxy covering seems to be very similar to that of the last species. Soon after the larva settles the same two dorsal ridges of white secretion make their appearance, but soon split up into transverse bands. Examined on the fifth day after hatching, a larva showed seven distinct transverse bands, the anterior one being in the shape of a horseshoe. At the same time the lateral margin of the body was observed to be fringed with stiff spines, seventeen to aside. At nine days the small horseshoe-like mass had extended so as to nearly cover the thorax, and the transverse bands had lengthened and widened until they presented the appearance of a nearly complete shield to the abdomen, serrate at the edges. Fifteen lateral tufts, such as were noticed in *C. Floridensis*, and such as Targioni figures in the larva of *C. rusci* (Stud. Sul. cocciniglie, Plate 1, Fig. 6) had appeared, though still small.

At this stage of growth, as with the last species, all development seemed to stop, although the specimens lived on for months, the temperature in the breeding-room probably not being favorable to the formation of the plates.

The smallest specimen in the collection with the plates already formed measures 2^{mm} long by 2^{mm} wide and 1^{mm} high. The color is light brown, and the wax has a somewhat translucent appearance. The dorsal plate is seven-sided; it is truncate anteriorly and pointed posteriorly. From each angle radiates a suture to the lateral edge, thus forming seven lateral plates, of which a single one is above the head, while above the anus is the suture between two. Through this suture projects the anal

spur. Each plate has a dark brown patch in its center, and in the center of each brown patch is a bit of the white secretion.

Habitat and *food plants.*—Found at Jacksonville and in Volusia County, Florida, on orange, quince, and on a species of *Eupatorium*, often in company with *C. Floridensis*, although it was by no means so common a species.

Genus **PULVINARIA** Targioni.

The genus *Pulvinaria* is not well defined. It was erected for those species of Lecaninae, in which the females after fecundation secrete below and at the posterior end of the body a mass of cottony material which forms a nidus for the eggs.

But one species has been described in this country—the *Pulvinaria innumerabilis* of Rathvon, a very abundant species in many localities upon the maples. It is figured upon Plate XI, Fig. 6. Interesting papers upon the species will be found in the proceedings of the Davenport Academy of Sciences, vol. ii, and in the American Naturalist, vol. xii, p. 655.

Genus **LECANIUM.**

This species includes those species of Lecaninae which are naked and at first boat-shaped, taking on, however, after impregnation very diverse forms, from nearly flat to globular.

Signoret has divided the genus into six sections.

Those species which we shall consider may be placed in three of these sections, which are separated as follows:

1. Flat; the lobes of the body visible; generally viviparous. L. HESPERIDUM.
4. More or less globular, the skin with dermal cellules; tarsi truly articulated and antennae 8-jointed .... L. HEMISPHAERICUM.
5. Rugose, with dorsal carinae .... L. OLEAE.

LECANIUM HEMISPHAERICUM Targioni.

(Plate VIII, Fig. 3 and 3 *a*.)

Adult female.—Shape approaching hemispherical with the edges flattened. Average length, 3.5^{mm}; width, 3^{mm}; height, 2^{mm}. The shape and proportions vary somewhat according as the scale is formed upon a leaf or a twig. Upon the rounded twig it loses something of its hemispherical form, becomes more elongated, and its flattened edges are bent downwards, clasping the twig. In such cases, of course, its height becomes greater and its width less. The color varies from a very light brown when young to a dark brown, occasionally slightly tinged with reddish when old. The oval cells of the skin vary in length from .01^{mm} to .04^{mm}, and each cell contains a large granular nucleus. The antennae are eight-jointed with joints 1 and 2 short and thick; joint 3 is the longest, and the succeeding joints decrease gradually in length to joint 8, which is longer than the preceding. Occasionally a specimen is found in which joint 5 is longer than 4, and I have seen individuals in which this was the case with one of the antennae while the other was normal. The legs are long and rather slender; the bristle on the trochanter is long; the articulation of the tarsi is very well marked. (This fact has suggested to Signoret that the insects of this series are less fixed than their congeners.) The tarsal digitules are, as usual, two long and two short, those

of the claws spreading widely at summit, and very stout at the base. The anal-genital ring (more easily seen than in the other species we describe) is furnished with eight long hairs. The anal plates are triangular with rounded corners, and are furnished with two long hairs upon the disk, and three much shorter ones at the tip.

The egg.—The egg is ellipsoidal in form, and 0.15^{mm} in length. In color it is whitish with a yellowish tinge, and is smooth and shining.

The newly-hatched larva.—The antennae are only 7-jointed, and the tarso-tibial articulation is hardly marked.

This bark-louse was first noticed in the orangery of the department, upon the leaves and twigs. It was also noticed upon various greenhouse plants, Disipyrus, Chrysophyllum, sago palm, and *Croton variegatum.* Shortly after being found here it was received from correspondents in California as infesting orange and oleander. During my visit to California I found it upon a single orange tree in the yard of Mr. Elwood Cooper, near Santa Barbara.

Actual observation shows the surmise of Signoret as to the locomotive powers of this insect to have been correct. We have seen the adult insects when removed from their positions crawl back with apparent ease.

LECANIUM HESPERIDUM Linn.

(Plate VIII, Fig. 2.)

Adult female.—Length, 3^{mm} to 4^{mm}. Color, yellow, inclined to brown upon disk, often quite dark; shape, elongate oval, nearly flat; smooth and shining, with sparse punctures upon the disk; after death the border above often becomes wrinkled radially for narrow space. The antennae are 7-jointed, the fourth and seventh subequal in length and the third but little shorter; 1, 2, 5, and 6, short and subequal. The legs are long and comparatively slender, with the tarsi shorter by one-fourth than the tibiae; the hair upon the trochanter is very long, and the tarsal claw is large; the tarsal digitules are long and much widened at their extremities; and also stout at the base. The anal ring is very small and is furnished with six long stout bristles.

Young larvae.—Long oval; antennae with six joints only, of which the third is the longest.

The male of this species has never been found, although it has been studied from the time of Linnaeus down. The species is viviparous. This is the commonest and most widely spread of any of the bark-lice we have considered. In the United States we have received it from all quarters. Our note-books show, for example, New York, District of Columbia, Georgia, Florida, Utah, California. All through the North it is to be found on greenhouse plants, and in the latitude of Washington and South it is found the year round on ivies, oranges, and other plants. In Europe Signoret speaks of finding it principally upon oranges, both in greenhouses and in the open air, but also states that it is found upon all surrounding plants.

We have no data concerning number of generations each year; in fact they are not well marked.

Three species of parasites have been reared from this bark-louse, and all have been described in Mr. Howard's paper on parasites. The first, *Cocophagus cognatus*, from *Lecanium hesperidum*, on orange in Florida; the second, *Comys bicolor*, from scales on ivy at Washington; and the third, *Encyrtus flavus*, from orange scales in California.

LECANIUM OLEAE Bernard.

THE BLACK SCALE OF CALIFORNIA.

(Plate VIII, Fig. 1.)

Adult female.—Dark brown, nearly black in color; nearly hemispherical in form, often, however, quite a little longer than broad; average length from 4^{mm} to 5^{mm}; average height 3^{mm}. Dorsum with a median longitudinal carina and two transverse carinae, the latter dividing the body into three subequal portions; frequently the longitudinal ridge is more prominent between the transverse ridges than elsewhere, thus forming with them a raised surface of the form of a capital H. The body is slightly margined; outer part of the disk with many (18–30) small ridges which extend from the margin half way up to center of dorsum. Viewed with the microscope, the skin is seen to be filled with oval or round cells each with a clear nucleus; the average size of the cells being from $.05^{mm}$ to $.06^{mm}$ in length, while the nuclei average $.02^{mm}$ in diameter. The antennae are long and 8-jointed, the two basal joints short; joint 3 longest, joints 4 and 5 equal and shorter, joints 6 and 7 equal and still shorter, joint 8 with a notched margin and almost as long as joint 3. Legs rather long and stout, the tibiae being about one-fifth longer than the tarsi. The anal ring seems to bear six long hairs.

The egg.—Long oval in shape, 0.4^{mm} in length, yellowish in color.

Newly-hatched larvae.—There is nothing very characteristic about the young larvae; they are flat, and their antennae are only 6-jointed.

The black scale is stated by Signoret to be properly in France an olive scale, sometimes, however, becoming so common as to occur on all neighboring plants also. In California we find it infesting the greatest variety of plants, and becoming a very serious enemy to orange and other citrus trees. I have found it at Los Angeles on orange and all other citrus plants, on olive, pear, apricot, plum, pomegranate, Oregon ash, bitter sweet, apple, eucalyptus, sabal palm, California coffee, rose, cape jessamine, *Habrothmus elegans;* and elsewhere upon an Australian plant known as *Brachaeton*, and also upon a heath. It preferably attacks the smaller twigs of these plants, and the young usually settle upon the leaves.

The development of this species is very slow, and it seems probable that there is only one brood in a year. Specimens observed by Mr. Alexander Craw at Los Angeles, which hatched in June or July, began to show the characteristic ridges only in November. Mr. Craw has seen the lice, even when quite well grown, move from twigs which had become dry and take up their quarters on fresh ones.

Although carefully looked for, the males, like those of so many other lecanides, have never been found.

A dark brown bark-louse has been sent me from Florida, on live oak, holly, oleander, orange, and one or two unknown plants, by Dr. R. S. Turner, of Fort George, which appears to be identical with *Lecanium oleae.* It is, however, by no means as abundant or injurious in that State as in California.

Natural enemies.—Enormous quantities of the eggs of the black scales are destroyed by the chalcid parasite *Tomocera californica*, described on p. —— of this report. Particulars as to the work of this parasite are given at the same place. Upon one occasion (August 25, 1880), I found within the body of a full-grown female a lepidopterous larva, which was very similar in appearance to the larvae of the species of *Dakruma*

described in my last report as destroying bark-lice. The specimen, however, was lost, and no more have been found since.

A number of beetles of the genus *Latridius* were found under scales which had been punctured by the *Tomocera*, but probably would not destroy the live insect. Many mites were found feeding upon the eggs and young. The infested trees were also swarming with the different species of lady-bugs (*Coccinellidae*).

Subfamily COCCINAE.

Genus **KERMES** Targ. Tozz.

(Plate IX, Fig. 1.)

The following characterization of this genus is taken from Signoret: Body perfectly globular or with a slight incision for insertion on the twig or branch. On an external examination no trace of antennae, legs, or even mouth parts is to be observed, and the insect presents precisely the appearance of a gall.

In the larvae, however, the true characters of the Coccinae are seen—multiarticulate lower lip and the absence of the anal plates. The larval characters are the ones which have been principally used in the description of species as they are easy to find. They (the larvae) are long, oval, the abdomen plainly segmented and deeply cleft at the extremity, except in *K. vermilio* and *K. ballotae*. Upon each segment there are several spines at the lateral edge and several hairs upon each disk. The lateral lobes have each a bundle of spines and a very long hair. Antennae 6-jointed, joint 3 longest. With all the legs the tibiae are shorter than the tarsi. With the adult the antennae and legs appear natural; but in very old individuals, which have secreted the horny-covering, the antennae are still present but deformed; so also with the legs, but the latter are sometimes entirely wanting.

The males resemble those of other Coccinae, and are inclosed in a little white felt-like sac. Head globular, with four eyes and six ocelli in *K. bauhinii* (the only species observed by Signoret). The antennae are very long, joint 3 longest, joint 10 shortest, and carrying several hairs with buttoned tips. Wings long. Abdomen long, with a short genital armature and two long bristles each side. Legs long, the tibiae longer than the tarsi, the latter with a long claw and the four ordinary digitules.

There are in the collection of the department several species belonging to this genus, which we have collected in Florida, Alabama, Louisiana, California, New York, and District of Columbia. For want of time I am unable to characterize these now. The species represented on Plate IX, fig. 1, occurs on *Quercus* ——— in California. The only North American species which has been described is *Kermes galliformis* Riley, described in the American Naturalist, vol. xv, p. 482 (June, 1881).

Genus **ERIOCOCCUS** Targ. Tozz.

The following characterization of this genus is taken from Signoret: Species early inclosed in felt-like sac, soon after fecundation and before oviposition. At the posterior extremity of the sac is a minute opening probably for the exit of the young. The young larvae approach those of kermes in appearance. They are more or less oval, rounded anteriorly, attenuated posteriorly; the lobes on each side of the anal ring highly developed. Upon the back are several distinct rows of spiny tubular *spinnerets;* these rows are altered in the adult to a considerable mass of

spinnerets. The antennae are 6-jointed in the female, 7 in the male larva, and 10 in the adult male. At the base of the antennae there is in some species an elongated tubercle. The males resemble those of *Dactylopius.* Some of the antennal joints are furnished with buttoned hairs. The balancer has but a single bristle. The stylet is very short.

ERIOCOCCUS AZALEAE, new species.

THE AZALEA BARK LOUSE.

Adult female.—Length of sac 3^{mm}; width, 1.5^{mm}, the female herself being somewhat smaller. The sac is dense, pure white, and covered with protruding filaments of white secretion, especially in the younger individuals; it is nearly oval in form, somewhat pointed at both ends. The female removed from the sac is dark purple, almost black; its shape is that of the sac, more rounded anteriorly and pointed posteriorly; its color is dark purplish, almost black; it is almost entirely naked, only a very small amount of the cottony secretion occurring on the ventral surface near anus. The whole dorsal surface is covered with long stout acuminate yellow spines, and also between these spines with minute pointed tubercles; there are also numerous pores; the underside of the body is comparatively smooth, bearing a very few of the shorter spines. The antennae are 6-jointed, but the bulb when the specimen is pressed under the cover glass often takes on the appearance of an additional joint; joints 1, 2, and 3 are sub-equal in length, joint 1 being perhaps a trifle the shortest; joints 4 and 5 are less than half as long as 1, and are subequal; joint 6 is nearly as long as 3; joints 3, 4, and 5 have each one or more bristles; joint 6 several, none, however, appearing buttoned at tip. The tibiae are two-thirds as long as the tarsi; tarsal digitules very long and slender, the claw large and strong. The lower lip is indistinctly 3-jointed, the basal joint widening slightly, and the final joint triangular; there are four or five hairs upon the disk and two at the summit. The anal lobes are small, each surmounted at tip by a very long bristle, and each bearing dorsally three of the long tubular spines, two at base and the other on the mesal edge, little more than half way to tip; there is also a bristle on the ventral surface. Anal ring with eight hairs.

Eggs.—Length, 0.27^{mm}; color, reddish purple. We have counted 50 eggs in one sac, and 52 eggs and 12 larvae in another.

Young larvae.—Color bright carmine, legs and antennae yellowish red. The large tubular spines of the adult are present, but in much smaller number, and are yellow in color. The antennae are plainly 6-jointed, with joint 6 longest.

The half-grown individuals are covered with a shaggy coat of filaments precisely similar to that covering the sac.

The sac containing the male is similar in all respects to that of the female, except that it is less than half the size and rather narrower in proportion to its length. No males have been bred.

Habitat.—On the twigs and stems of azalea in the department conservatories at Washington; quite abundant.

Natural enemies.—The majority of the specimens of *E. azaleae* collected were parasited by the chalcid—*Coccophagus immaculatus* Howard, described farther on.

Genus RHIZOCOCCUS Signoret.

This genus was erected by Signoret* to receive an insect (*R. gnidii*) which he found on the roots of *Daphne gnidium*, and which differs, according to his description, from the species of *Eriococcus* in no important anatomical character, except in the antennae of the female being 7-jointed. The specimens (female only) which Signoret studied were naked; but he had not sufficient material to ascertain if the insect makes a sac or not in its most advanced stage.

During the past year I have studied two bark-lice which agree with the characters given for *Eriococcus*, except that the females have 7-jointed antennae, and remain naked until they are fully grown. These species I place provisionally in the genus *Rhizococcus*, and submit the following characters, drawn from the species described here, for that genus.†

Genus RHIZOCOCCUS.

Antennae of larvae and of the adult female 7-jointed; ano-genital ring with eight hairs; tarsi of both male and female each with four digitales; margin of body of young and of female in all stages fringed with tubular *spinnerets*, which are covered with a waxy excretion; adult male with single ocellus behind each eye, and a pair of bristles on each side of penultimate abdominal segment, each pair supporting a long white filament excreted by numerous pores at its base. The fully developed female makes a dense sac of waxy matter within which the eggs are laid and the shriveled body of the insect remains; the full-grown male larva makes a similar sac within which it undergoes its metamorphoses.

RHIZOCOCCUS ARAUCARIAE (Maskell).

THE NORFOLK ISLAND PINE COCCUS.

(Plate X, Fig. 1*a*—1*g*.)

Eriococcus araucariae Maskell. Transactions and Proceedings of the New Zealand Institute, vol. xi, p. 218.

During the summer of 1880, I found very common on the Norfolk Island pine (*Araucaria excelsior*) growing in open air in southern California, a bark-louse, which is probably the species that was described in New Zealand by Mr. Maskell the year previous under the above name.

When a tree is badly infested with this pest it becomes blackened with a black fungus, which I presume is *Fumago salicina*, which accompanies coccids on orange and other trees. This is often the first indication of the presence of the insect which is observed. But when an infested tree

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*Annales de la Soc. Ent. de France, 1875, p. 36.

† M. Signoret, to whom I referred specimens of *R. araucariae*, is of the opinion that this species is not congeneric with his *R. gnidii*, and he advised me to establish a new genus for the species on araucaria. The mode of life of the two species is certainly very different, *R. gnidii* living on the roots of a plant, and *R. araucariae* upon the leaves; and it seems probable that the former never makes a sac. But until more is known of *R. gnidii* or of some undoubtedly congenic form, and structural differences between it and *R. araucariae* are discovered, I am unwilling to assume the risk of proposing an unnecessary generic name. In fact the great similarity between the species described here and those belonging to Ericoccus leads me to believe that it would be better to enlarge the characters of that genus so as to include species in which the antennae of the female are 7-jointed, and which are naked in their adolescent stages. The fact that it is sometimes difficult to decide whether an antennae is 6-jointed or 7-jointed (see description of *E. azalcae*) confirms this belief.

is carefully examined, numerous white cocoon-like sacs containing the full-grown insects may be seen closely applied to the sides or bases of the leaves. Frequently these sacs are so massed at the ends of the twigs that the bases of the leaves are completely covered. The immature insects are not so easily seen with the unaided eye, as they differ but little in color from the tree. They are greenish yellow, and are usually to be found in the angles formed by the bases of the leaves. The larvae of both sexes and the adult females are similar in form (see Plate X, Fig. 1*b*.) The posterior end of the body is furnished with two prominent lobes, each terminated by a long hair. Between these lobes there is a conical mass of white waxy matter projecting backwards. The margin of the body is fringed with a row of tubular *spinnerets*. These *spinnerets* are more numerous on the adult female than on the larva; in both stages each one is covered with waxy matter, which often extends beyond the end of the *spinneret*. Excepting these filaments and the caudal tuft, but little excretory matter is to be seen; so that although the insect resembles a mealy bug in the form of its body it differs greatly in appearance. The female when full grown measures 2.3^{mm} (.09 inch) in length. When the female is ready to lay her eggs she excretes a cocoon-like covering to the body, composed of white waxen threads (Fig. 1). This sac is dense like felt, but easily torn; it is open on the middle line of the ventral surface or very much more delicate on that part. It adheres to the tree quite firmly, remaining where excreted after the death of the insect. As the eggs are laid, the body of the female shrinks away, making room for them, and finally it becomes a very small pellet in the anterior end of the sac, the remainder of the space being filled with eggs. These are light yellow in color. When the male larva is ready to undergo his metamorphoses, he secretes a covering to his body resembling the sac excreted by the female, except that it is very much smaller, measuring only 1.33 ^{mm} (.05 inch) in length (Fig. 1). From this sac the adult insect emerges as a delicate fly-like creature, with two large wings and a pair of long waxen filaments projecting from posterior part of the abdomen; these filaments are very conspicuous, being white and longer than the body of the insect. (See Plate X, Fig. 1*a*.)

Color of body white with many irregular brown markings.

I have not sufficient data to ascertain the number of generations of this insect each year. August 27, I found specimens in all stages of development.

RHIZOCOCCUS QUERCUS, new species.

(Plate X, Figs. 2, 2 *a* and 2 *b*.)

Female.—The tubular *spinnerets* are more numerous than in *R. araucariae*; and are not confined to the margin of the body; but are distributed irregularly over the dorsum. They vary much in size and are curved and acuminate (Fig. 2 *a*). Tarsi less than one-half as long as tibiae. Hair on trochanter nearly as long as femur.

Male.—I have only one specimen, which is much shriveled; this resembles *R. araucariae* except that the ocelli are placed further caudad of the eyes than in that species.

Described from 17 ♀ 1 ♂, and very many larvae, all mounted in balsam.

Habitat.—On scrub oak at Rock Ledge, Fla.; upon gall-berry, oak, and grass at Fort George, Fla. (Dr. R. S. Turner). The sacs (Fig. 2) of this species, of which I have very many specimens, very closely resemble those of *R. araucariae*. The sacs of the female are all large, indicating that the species is naked till full grown.

Genus DACTYLOPIUS.

To the genus Dactylopius belong the insects commonly known as mealy bugs. The antennae of the female are 6-jointed in the larva, and 8-jointed in the adult; the male larva has 7-jointed antennae. The tarsi are furnished with four digitules and the anal ring with six hairs.

DACTYLOPIUS ADONIDUM (Linn.) Signoret.

THE COMMON MEALY BUG.

(Plate XI, Fig. 1, 1 *a*, —, 1 *d*.)

Coccus adonidum Linn. Syst. Nat. (1767), 740, 4.
Dactylopius adonidum Signoret. Ann. de la Soc. Ent. de France, 1875, p. 306.

Under the specific name of *adonidum* have been classed the various species of "mealy bugs," common in green-houses throughout the civilized world. It would be difficult, if not impossible, to determine beyond a doubt the particular form to which Linneus gave this name, more than one hundred years ago. Consequently the best course to follow is to accept the conclusions of Signoret, who has given this genus the most careful study that it has yet received. The following is the description of the species to which he applies the name given by Linneus:

The *female* is $2\frac{1}{2}^{mm}$ to 3^{mm} (0.1 to .12 inch) in length, and 1.5^{mm} (.06 inch) in width; white, a little yellowish, with a brown band upon the middle of the back, the legs and the antennae a little brownish, powdered with a great quantity of floury matter secreted through pores scattered over the body; in addition to this, each lateral lobe or segment presents a secretion which forms a border of woolly appendages around the body varying in length; those near the posterior end of the body are longer, and four at the abdominal extremity are very long; the two internal ones are longest, equaling and sometimes surpassing the length of the body. The antennae are composed of eight points, of which the eighth is the longest, and the third and the second, fourth and fifth the shortest and of equal length; sixth and seventh a little longer than the fourth and fifth. The antennae are slightly pubescent, especially at the summit of each joint. The legs are quite long, slightly pubescent, the tibia twice as long as the tarsus; claw strong and long, with the digitules slender and furnished with a very little knob. The abdomen presents upon the suture of the first and of the second segment and upon the median line a cicatrice more or less visible and more or less rounded; upon the suture of the fourth and fifth, on each side, nearer the margin than the median line, an oblong cicatrice; upon each segment, a great quantity of pores in the form of rounded points and some scattered hairs. Each lateral lobe presents a space with rounded pores, then two conical spines more or less strong; this is the apparatus secreting the cottony matter of which is formed each lateral appendage; the lobes of the extremity of the body have many more pores, and the conical spines are much larger; a little lower down arise two hairs, one of which is large; around these is condensed the secretion furnished by the pores. The anal ring is very large, dotted, and his six quite long hairs.

The *larva*, varying in size according to its age, is more flat, of the same elongated form, and of the same color, but differs in the antennae, which have only six joints. Other individuals, of a uniform shape and more elongated, have 7-jointed antennae; these are the males which are to undergo another molt, which very often is indicated by the rolling up of the oval setae and sometimes by the future antennae and legs,

which are already indicated within the members of the larva. In this type the tibia is hardly one-third longer than the tarsus.

The *male* we bred from larvae with 7-jointed antennae; in order to undergo their metamorphoses, they form little cottony sacs. The adult is long, of a brown, neither yellow nor red, with the segmentations paler. As it becomes older it grows darker, especially upon the head and the corneous pieces of the thorax. The wings are long, largely rounded, of a gray more or less deep, reddish towards the side. The poisers are long, yellow, with a single bristle hooked at the extremity. The prothorax is long, rounded upon the sides, straight in front, rounded behind, with a black arc upon the mesothorax. The abdomen is long, terminated by a rounded armature, thick, presenting some hairs. The lateral lobes of the last segment present two long threads of white cottony matter, secreted by numerous rounded pores; in the middle of each lobe are two long hairs and one smaller, around which the matter is condensed; the lobes above present much smaller ones, with two or three rounded pores. The head is thick, in the form of a ball a little truncated in front, more convex below than above, and pubescent, except upon the pigmentary circle of the eyes and ocelli. We have not determined exactly the number of the ocelli, which we think is four. The legs are long, with a large tarsus, flat, pubescent, presenting a very long and narrow claw. We have not been able to see the digitules of the claws. As to those of the tarsi, they are not larger than ordinary hairs with a very little knob at the extremity.

We have reproduced the figures of this species given by Dr. Signoret (Plate XI, Fig. 1). 1, lateral lobe of the extremity of the abdomen of the female; 1 *a*, antennae of the female; 1 *b*, antennae of the male; 1 *c*, leg with the four digitules of the female; 1 *d*, the anal ring with six hairs.

DACTYLOPIUS DESTRUCTOR, new species.

THE DESTRUCTIVE MEALY BUG.

(Plate XI, Fig. 3, ♀; Plate XXII, Fig. 2, ♂.)

Adult female.—Length, 3.5 ^{mm} to 4 ^{mm}; width, 2 ^{mm}. Color, dull brownish yellow, somewhat darker than with *D. longifilis;* legs and antennae concolorous with body. The lateral appendages (seventeen on each side) are short and inconspicuous and are subequal in length. Upon the surface of the body the powdery secretion is very slight. In spite of the small size of the filaments, the *spinnerets* and the supporting hairs are as numerous and as prominent, or nearly so, as in *D. longifilis;* those upon the anal lobes being especially long. Antennae 8-jointed; joint 8 is the longest and is twice as long as the next in length, joint 3. After 3, joints 2 and 7, subequal, then 5 and 6, joint 4 being the shortest. The tarsi are a little more than half the length of the tibiae and the digitules are as in the preceding species; claws strong.

Egg.—Length, 0.25 ^{mm}; shape, rather long, ellipsoidal; color, light straw-yellow.

Young larva.—Rather brighter colored than the egg. Antennae 6-jointed with the female, with the same relative proportions as in the preceding species. Tarsi considerably longer than the tibiae. The lower lip is large, conical, and reaches almost to the posterior coxae.

Male.—Length, 0.87 ^{mm}; expanse of wings, 2.5 ^{mm}. Color light olive-brown, lighter than in following species; legs concolorous with body; antennae reddish; eyes dark red; bands darker brown than the gen-

eral color; anterior edge of mesoscutum and posterior edge of scutellum darker brown. Body, as will be seen from measurements, rather small and delicate compared with the size of the wings; head small, with almost no hair; antennae 10-jointed, joints 3 and 10 longest and equal; joints 2, 6, 7, 8, and 9 nearly equal and considerably shorter than 3 and 10; joints 3 and 4 subequal and a trifle shorter than the following joints. The lateral ocelli are each just laterad of the center of the eye, and not at its posterior border, as in the following species. (This, however, is a character which will not hold with specimens long mounted.) Prothorax short; legs sparsely covered with hairs; tarsal digitules extremely delicate, and the button is very difficult to distinguish; we have been unable to discover a trace of the pair belonging to the claw. The anal filaments and the supporting hairs are similar to those of the following species.

This species is readily distinguished from *D. longifilis* by the shortness of the lateral and anal filaments in the female. Indeed, for convenience's sake, we have been in the habit of distinguishing them as the mealy bug with short threads and the one with long. The life-history of this species differs quite decidedly from that of *D. longifilis*, in that true eggs, which occupy quite a long time in hatching, are deposited. The female begins laying her eggs in a cottony mass at the extremity of her abdomen, some time before attaining full growth, and the egg-mass increases with her own increase, gradually forcing the posterior end of the body upwards until she frequently seems to be almost standing on her head. The young larvae soon after hatching spread in all directions and settle—preferably along the mid-rib on the under side of the leaves, or in the forks of the young twigs, where they form large colonies, closely packed together. As mentioned in the description, they are only slightly covered with the white powder, and many seem to be entirely bare, with the exception of the lateral threads.

Habitat.—This species is very abundant upon almost every variety of house-plant in the department green-houses, but especially so upon the Arabian and Liberian coffee-plants. On these plants they were found, curiously enough, in small pits or glands on the under side of the leaf, along the mid-rib. Almost every pit, of which there is one at the origin of each main vein, contained one or more young mealy bugs, and the larger ones whole colonies. The name *destructor* is, however, proposed for this insect from the damage done by it to orange trees in Florida, especially at Jacksonville and Micanopy, where it is the most serious insect pest of the orange.

Natural enemies.—The Chalcid parasite, *Encyrtus inquisitor* Howard, described in this report, was bred from a specimen of this mealy bug collected at Jacksonville, Fa. A small red bug was observed by myself and several of our correspondents to prey upon the mealy bug. The larvae of another species have been found, but the mature form has not been obtained. These last have the faculty of changing color quickly from red to brown.

The very curious larvae of a lady-bird beetle, known as *Scymnus biocu-latus*, were found feeding upon the eggs of the mealy bug at Orange Lake. These larvae mimic the Dactylopii so closely that they might easily be taken for them. They are covered by a white secretion, and from each segment exudes a white substance which forms long filaments like those of the mealy bug. Removing the powder the larvae are seen to be yellow in color, with two roundish dusky spots on the dorsum of each thoracic segment. Each segment of the body is furnished laterally with one long bristle and a number of small ones.

DACTYLOPIUS LONGIFILIS, new species.

THE MEALY BUG WITH LONG THREADS.

(Plate XI, Fig. 2, ♀; Plate XXII, Fig. 1, ♂.)

Adult female.—Length, 4^{mm} to 5^{mm}; width, 2^{mm}. Color very light dull yellow, legs and antennae a trifle darker. Body rather sparsely covered with a whitish powder. The lateral appendages, numbering seventeen on each side, are long, the two posterior ones on each side very long—equaling if not surpassing in length the whole body. Antennae 8-jointed; joint 8 longest, then 3, and then 2, the difference being slight; joint 5 is next in size, and 4, 6, and 7 are nearly if not quite equal. The tarsi are only one-third as long as the tibiae. The four tarsal digitules are present and are knobbed; those of the claw are short and thick (although by no means so much so as in Lecanium), and the others very slender, and with a very delicate knob. Antennae, tarsi, and distal ends of tibiae quite hairy. Along the lateral edge of the body are many tubercular *spinnerets*, in which large tubes can be seen running to the tips. Below these *spinnerets*, on each lobe, is a pair of sharp conical spines, and several longer or shorter hairs. The conical spines upon the last two segments are much larger than those upon any other. The anal lobes bear each a long hair. The anal ring is prominent, and bears the customary six large tubular hairs.

Larva.—In color similar to the adult. Antennae 6-jointed, the sixth joint longest—as long as the three preceding joints together; the others short and subequal. In the male larva the antennae are 7-jointed. The tarsi somewhat longer than the tibiae.

Male.—Wing expanse, 2.6^{mm}; length of body, 1.3^{mm}. Color light olive-brown; antennae and legs darker brown; band slightly darker than the general color; anterior border of mesoscutum and posterior edge of postscutellum dark brown; eyes dark red; wings slightly dusky, with a faint bluish tinge. Body long and stout; head large, and strongly pilose behind the eyes. Antennae 10-jointed; joint 3 longest, joint 6 next; joint 10 a trifle longer than 9, and about the same length as 7 and 8. Prothorax very long; legs very hairy; only two tarsal digitules are to be seen, those of the claw being rudimentary; they are short, very delicate, and with an extremely delicate button. Anal lobes each with long filaments, which, when the wax is removed shows two long supporting hairs and one short one. The visible ocelli are seen just behind the lateral angle of the eye, on each side.

This species is one of two which are very common in the department green-houses, and seems to be more abundant upon the ferns and the plants of the Euphorbiaceous, genus *Croton*, than upon any, others. The female is very active when disturbed, and is not found with the cottony egg-mass to be seen with many species of Dactylopius. The young is born enveloped in a thin pellicle or pseudovum, which splits a few moments after birth and allows it to escape. The female surrounds herself with the cottony material, and the young cluster around and under the mother for some time. The growth is evidently quite rapid, and individuals of all stages are to be found at almost any time. The male larva, some time before pupation, forms for itself a little cottony sac or cocoon, in which it undergoes its transformations.

Genus **PSEUDOCOCCUS** Westwood.

This genus is very near *Dactylopius*, and nearly all the characters are identical. In the adult female, however, the antennae are 9-jointed, those of the female larvae being 6-jointed and of the male larvae 7-jointed. The tarsi are not provided with the customary long digitules except in *Pseudoccus hederae*.

PSEUDOCOCCUS ACERIS (Geoffrey).

This species, stated by Signoret to be one of the most common in France, would seem to be comparatively rare in the United States. It has been collected by Miss Emily Smith on maple (*Acer saccharinum*) at Peoria, Ill., and forms the subject of quite an extensive article by her in the North American Entomologist, vol. 1, p. 73 (April, 1880). She also notes its occurrence at Lancaster, Pa., where it has been collected by Dr. Rathvon. The following description of the species is compiled from Signoret and Miss Smith:

Adult female.—Color, bright yellow (Smith), reddish yellow (Signoret). Length from 4^{mm} to 5^{mm}. Shape, rounded oval, as large behind as in front. The dorsal integument is smooth, with the divisions into segments obscure; it is filled with *spinnerets* in the form of pores, and is also furnished with many delicate hairs, especially numerous upon the median part of each segment and at the extremity of the abdomen. The antennae are long and delicate, 9-jointed, second and third longest, the others diminishing in size and length except joint 9, which is longer than the preceding joint and acuminate at tip. The under lip is long, acuminate at tip, which is furnished with many hairs. The tibiae are nearly three times as long as the tarsi. The tarsal claws are rather short and toothed on their inner side, sometimes truncate at tip; there are only two digitules, those of the claw, the others being only simple hairs. The anal genital ring is large, punctated, and supports six quite long hairs.

The egg is light yellow in color when first deposited, later becoming yellow brown. Dimensions given by Miss Smith, 5^{mm}–6^{mm} long, and 3^{mm}–4^{mm} wide; probably 0.5^{mm} to 0.6^{mm} x 0.3^{mm}–0.4^{mm}.

The young larva.—Color, reddish yellow; shape, elongated oval, narrow behind. Antennae 6-jointed, joint 6 as long as the three preceding joints together. The lower lip is 2-jointed. The body is surrounded by a series of spines and upon the disk of each segment is series of eight tubercular *spinnerets*, with which alternate short hairs; in front of the head between the eyes are several longer hairs. The anal ring with six hairs; the lateral lobes large, each with one very long hair and several shorter ones. The tarsi a third longer than the tibiae.

The male larva is red and has 7-jointed antennae.

The male.—Color, red; antennae, 10-jointed; joint 1 short and stout; joint 2 twice as long as 1; joint 3 three times as long as 1; joints 4 to 10 similar in size and form, decreasing slightly in length. Legs hairy; tarsi one-half as long as tibiae. Anal filaments longer than all the rest of the insect.

Genus **COCCUS**.

In general appearance the genus Coccus resembles the foregoing considerably, but may be distinguished by the following characters:

The antennae are 7-jointed with the adult female, 6-jointed with the female larva, and 5 jointed with the male larva. The legs are very

slender. The anal ring is destitute of hairs. The eyes are smooth and there are two ocelli, this last character separating the genus from the following divisions.

COCCUS CACTI.

THE COCHENILLE INSECT.

The following description is taken from Signoret:

Adult female.—Dark reddish brown in color. From 6^{mm} to 7^{mm} long, 4^{mm} wide, and from 2^{mm} to 3^{mm} high. Covered with a large quantity of white cottony powder; when this substance is removed it is seen to be strongly segmented, prismatic in form, in consequence of a dorsal carina, especially visible in dried specimens, and truncate behind, which gives it the form of a lance-head. The antennae are short, conical, 7-jointed, the four basal joints short, thicker than long, joint 5 as long as thick, joint 6 a little longer, with a whorl of short hairs, joint 7 as long as the two preceding together, with ten or eleven short hairs.

Larva.—In the newly-hatched female larva the antennae is 6-jointed, slender, joint 2 very short, 3 longer, but it soon becomes deformed and thick, even in the larva state. There are other larvae in which the antennae only seem to show five joints, the second having blended with the third; there is also another type of larvae which show only five joints. These differences indicate different states, either of the newly-hatched larvae or of the female or male larvae. For these last we take those in which the legs are very slender and the antennae of which, een upon the cast skin, show a very short basal joint, a second five times as long, the third and fourth short, and the fifth longest of all and a .ittle slenderer.

The legs also vary according to the age and sex. In the old individuals they become short, thick, and often with very indistinct joints; when not deformed they are generally thick, with the tarsi longer than the tibiae in the larva, and almost as long in the old female. In the male larvae the legs are slenderer, with the tarsal claws very long and accompanied by the four-buttoned digitules. The skin is smooth, with groups of *spinnerets* here and there and a few scattered hairs. The newly-hatched larva is oval, larger before than behind; the antennae and legs are long; upon the lateral edge of each segment are two spines, a line of hairs each side of the median line, and a group of *spinnerets* near the lateral spines; between the double median line and the lateral spines is another simple line of short hairs.

Male.—The male is of a reddish yellow, darker upon the head and thorax, with brown legs and antennae, and light gray wings. The head is thick, rounded, acuminate between the antennae, with four smooth eyes and two ocelli. The antennae are 10 jointed, with the fourth, fifth, and tenth longest, all joints furnished with a short pubescence, the hairs of which appear truncate; at the tip of the fifth and last joints is a much longer pubescence formed of buttoned hairs; joints 1 and 2 almost smooth, showing but one or two hairs (this is a character seen in no other genus). The legs are very long, with a sparse pubescence formed of little hairs scattered over the disk and upon the sides; the tarsus is a third shorter than the tibiae and furnished with two very long digitules; the claw is very slender and very long, with its two digitules extending a little beyond it. The abdomen, paler in color, is furnished upon each side with a transverse line of small hairs; the lateral lobes of the extremity each with a protuberance covered with many *spinnerets*, and

at its end furnished with three hairs which support the waxy matter of the two caducous filaments, which are twice as long as the body of the insect. Between the two filaments is the copulating armature, composed of a very large tubercle, accompanied by a stylet shaped like a ventrally curved claw. Upon the middle of the abdomen is sometimes seen a small brown spot which forms a longitudinal band. Upon the prothorax anteriorly is a darker transverse band as well as upon the meso and metathorax, and sometimes three longitudinal bands from the neck to the metathorax. Ventrally, the framework of the sternum is browner. Although several individuals have been examined, we (Signoret) have never seen any balancer. The wings extend for a third of their length beyond the abdomen, and are widely rounded at the extremity; the nervures are brownish yellow with a reddish tint towards the body.

The cochenille insect of commerce, although an indigene of Mexico, has been imported into various other countries and is cultivated notably in the Canary Islands, in Algiers, and in Spain. Specimens from China seem, according to Signoret, to be but varieties of this species. Specimens of what is probably this species were collected by Dr. R. S. Turner at Fort George, Fla., upon a yellow flowering cactus; species unknown.

Genus **ICERYA** Signoret.

Antennae 11-jointed; body covered by a cottony matter of several shades of color and with a secretion of still longer filaments. Skin with rounded *spinnerets* and with long scattered hairs. Antennae of nearly the same size throughout their whole length and with a long pubescence. The digitules of the claw elongated and buttoned; of the tarsus as simple hairs. Genital apparatus terminating in a tube internally with a reticulated ring like a sphincter and without hairs at its extremity. Antennae of the larvae 6-jointed with a very long pubescence, and with four hairs upon the last joint much longer than the others. Lateral lobes of the extremity of the abdomen with a series of three very long, frequently interlaced bristles.

ICERYA PURCHASI Maskell.

(Plate IX, Fig. 2.)

Adult female.—Length 4^{mm} to 8^{mm}. Color dark orange-red, legs and antennae black, dorsal surface more or less covered with a white or yellowish-white powder. The large egg sac is tinged with yellow and is longitudinally ribbed; it is a little longer than the whole body of the insect, and is filled with a loose white cottony mass containing the eggs. Over the whole surface of the body the skin is filled with circular *spinnerets*, each containing several openings; body clothed with short black hairs, dense at the margin of the body, forming tufts, and absent from the ventral side of the abdomen. Tarsi two-thirds the length of the tibiae; digitules of the claw very delicate and slender, and buttoned at tip.

Egg.—Red in color, true oval in shape, 0.7^{mm} long.

Newly hatched larva.—Reddish, inclining to brown in color. Antennae 6-jointed, joint 1 short and thick, joints 2, 3, 4, and 5 longer, slenderer, subcylindrical, and subequal, joint 6 larger and club-shaped. (There is sometimes an additional joint between 5 and 6.) All the joints except 1 with a few hairs; joint 6 with several, of which four are very long. Legs long and slender; tibia and tarsus with several long hairs; digitules of the tarsal claw proportionately much larger

than in the adult, bent like hooks, and buttoned at tips; tarsal digitules represented by simple hairs. The six anal bristles are very long and conspicuous, each arising from a quite prominent tubercle. Six longitudinal rows of *spinnerets* are seen upon the dorsum, two rows sublateral and the other four more nearly in the middle. These rows soon become confused, and are no longer distinguishable after the larvae have become somewhat grown. Alternating with the *spinnerets* are rows of hairs.

As the larva grows its appearance gradually changes. The outline, still oval, becomes more irregular, and its color is of a darker red, nearly brown. The six anal hairs become shorter until they are indistinguishable from the other hairs of the body, which become more abundant, especially on the abdomen, where the lateral tufts of the adult begin to appear early.

The young larva soon begins to excrete tufts of a yellow waxy matter along the dorsal surface of the body and the lateral margins. The excretion on the dorsum consists of four pairs of large tufts, while along the margin is a simple row of poorly defined smaller tufts. Between the dorsal and lateral excreted masses the body is naked, thus leaving on each side a bright red line, which contrasts strongly with the yellow excretion. Ventral surface of the body naked. From a row of large *spinnerets*, around the lateral edge of the body, project long delicate semi-transparent filaments, and from between the posterior pair of dorsal tufts there projects a long white waxy filament (often 10^{mm} or more in length), on the end of which is usually a drop of clear fluid. This filament is very brittle, so that a slight jar will cause nearly every one on a tree to break.

The insects seem first to settle upon the leaves, preferably along the midrib, and afterwards to migrate to the twigs and branches, or even the trunk.

Habitat.—I found this species first during the summer of 1880, in a grove of 130 lime trees, owned by Mr. W. W. Stowe, at Santa Barbara, Cal. The trunks and limbs were in many cases so completely covered as to appear white, the leaves were turning yellow, and the tree was apparently dying. They had spread to surrounding orange orchards, and I learn this year from Mr. C. W. Coffin, of the same place, that they are spreading with amazing rapidity.

It seems probable that it is an Australian species. The specific name which we have adopted was given this insect by Mr. Maskell, in the Trans. and Proc. New Zealand Inst., vol. xi, p. 221. It was found on a hedge of "Kangaroo acacia," in Auckland, New Zealand, in great numbers, but upon that single hedge alone.

It is the same insect spoken of by Professor Riley, in the department report for 1878, under the name of *Dorthesia characias* Westw., where he stated that it had recently been imported into South Africa from Australia, and had become such a scourge as to attract the attention of the government. The first published notice of its appearance in this country which we have been able to find is in the California Agriculturist and Artisan for December, 1877, by Dr. A. W. Saxe, of Santa Clara, who stated it as his belief that the pest was originally brought from Australia on some plants imported by Mr. George Gordon, of Menlo Park, in 1868; and that it spread all along the coast counties. In the same article a letter from Dr. H. Behr, of San Francisco, identifies it as a species of Dorthesia.

Dr. Hagen, of Cambridge, Mass., informs me that he has seen the same species in green-houses at Cambridge.

Genus ORTHEZIA Bosc.

Adult female.—Antennae 8-jointed, joints 2 and 8 longest, then 3, 4, and 5 almost equal, then 6 and 7 smaller and subequal, joint 1 thick and short, as wide as long. Legs of medium size, with the tarsi nearly half the length of the tibiae. Claw medium, with a small hair at the base on each side; no digitules on the tarsus. The body is of an elongate oval, strongly rounded behind, constricted in front, emarginate at the base of the antennae, rounded at apex, anal-genital ring large and with six hairs. The whole body in all stages covered with a calcareous laminated secretion, which, with the adult female, becomes more elongated posteriorly and forms a sac containing the eggs mixed with a fine down. Later, when the young are born, they remain in the sac until they have themselves secreted a sufficient amount of the lamellar material to cover them. This secretion is formed by hair-like *spinnerets*, scattered in considerable number over the whole surface of the body, and much more abundant in the perfect insect than in the larva.

Newly-hatched larva.—Elongate oval, rounded in front, narrow behind. Antennae 6-jointed, joint 6 longest, a little longer than 4 and 5 together; joint 3 next to the longest. Legs and mouth parts well developed, the latter extending beyond the anterior border and having the appearance of being upside down.

Female larva.—Longer, with the sides more nearly parallel. Antennae 7-jointed, joint 7 very long, joint 3 next, joint 4 shortest; joint 7 ends in a short obtuse hair and bears eight short spine-like hairs, and, near the middle, a stronger obtuse hair. The legs are as usual, tarsi almost almost as long as tibiæ, pubescent.

Male larva.—What we consider (with some doubt, however) to be the male larva, is rounded, oval in shape, and is remarkable for the peculiarities of its antennae. The basal joint is very large and very long, and at its tip the rest of the antenna makes a bend. Joint 2 is almost as long as 1 but much slenderer, and bears four hairs upon its distal end and two smaller ones upon its disk; joints 3, 4, 5, and 6 are smaller and subsequal, each one broadening at tip and bearing two small hairs; joint 7 is the longest of all, is a little bent, bears a very long hair at the tip, a little below it is a much smaller one, and two on each side.

The male.—Very long, with multiple eyes. The antennae are very long, filiform, each joint up to 9 with a swelling at tip; joints 1 and 2 very small, 3 very long, 4 to 8 a third shorter, subequal, 9 shorter still; all joints with a short pubescence. Thorax very long; wings a little acuminate at tip. Abdomen enlarged in the middle, bearing along each side a line of hairs, and upon the penultimate segment a band of tubular hairs which secrete a transparent caducous material. Legs long, pubescent, with a very long claw. Sexual apparatus large, forming about one-fifth the length of the abdomen.

In the collection of Professor Uhler are a number of specimens of a species of Orthezia labeled "Canada" and "Grimsby, Ontario." One specimen bears the label "On Golden Rod." These specimens seem, on superficial examination, to be specifically identical with a type specimen of Walker's *Orthezia americana*, which is also in Professor Uhler's collection. I have found immature specimens of what may be the same species upon the common burdock (*Arctium officinale*) at Ithaca, N. Y. (See plate IX, fig. 3).

PART III.

REPORT ON THE PARASITES OF THE COCCIDAE IN THE COLLECTION OF THIS DEPARTMENT.

MAY 7, 1881.

SIR: In accordance with your directions, I have the honor to submit the following report upon the parasites of the Coccidae in the department collection.

Respectfully,

L. O. HOWARD.

Prof. J. HENRY COMSTOCK,
Entomologist to the Department of Agriculture.

INTRODUCTORY.

The importance of the parasitic enemies of noxious insects has always been recognized by workers in economic entomology, and more or less space has generally been devoted, in treatises on injurious insects, to the description of these parasites. Beyond the mere description, however, almost nothing has been done, and we have reason to believe that, with the practical agriculturist, in considering the question of dealing with his insect foes, the point of encouraging their natural enemies is generally, if not invariably, overlooked. In fact, the very phrase, "encouraging the natural enemies," although so often used, is a very indefinite one, and conveys no idea upon which the farmer can act; but the entomologist has rarely gone beyond that mere bit of advice, and shown just *how* the natural enemies are to be encouraged. Indeed, so far as parasites are concerned, the problem becomes a very delicate one.

In the New York Semi-Weekly Tribune for August 10, 1877,* in speaking of the remedies for the cabbage worm (*Pieris rapae* L.), Professor Comstock deprecated the indiscriminate crushing of the chrysalides collected under trap boards on account of the large percentage which contain parasites. He recommended, instead, the collecting of the chrysalides and the placing of them in a box covered with a wire screen which should permit the parasites to escape, and, at the same time, confine the butterflies so that they could be easily destroyed. The same author in his Report upon Cotton Insects (1879), p. 230, recommends a similar course with the pupae of the cotton worm (*Aletia argillacea* Hübn.).

This plan can undoubtedly be used to good purpose with many lepidopterous insects, and is mentioned here as being almost the only practical suggestion with regard to the preservation of parasites on record.

With the parasites of bark-lice this plan naturally offers us nothing of use. There is, however, a point to be considered which will be suggested by the following facts: The ivies upon the department grounds are badly infested by a scale insect known as *Lecanium hesperidum* L. This scale is parasited quite extensively by a large Chalcid known as *Comys bicolor* m. When the parasites have attained full growth and changed to pupae, their presence is shown by the black color of the scale. Now, if an application of whale oil soap solution, or other insecticide be made to the vines while the parasitic larvae are yet young, hundreds of them will be killed with the scales. If, however, the application be deferred until some of the scales are observed to turn black, then the parasites will escape unharmed to deposit their eggs in such of the scales as

*Published again in the Prairie Farmer, May 26, 1879, and quoted by Thomas, in Trans. Dept. Agr. Ill., 1879, Ent. Rept., p. 24.

may have survived the effects of the drenching. This may seem like a small point to take into consideration, and, indeed, it would hardly be worth noticing in many cases; but, again, in many others, certainly in the case of the *Lecanium* just mentioned, the results would well repay experimentation.

The question of the transportation of useful parasites from localities where they are abundant to such places as most need them, is one which has attracted some little attention. Some years ago Dr. Fitch (6th N. Y. Rept.) discussed the feasibility of importing the European parasites of the wheat midge (*Diplosis tritici*, Kirby) into this country, and went so far as to address a letter to Mr. Curtis, then president of the London Entomological Society, asking for live specimens of these parasites; but, owing to their rarity at that time in England, nothing came of the proposed experiment.

Mr. Walsh is said to have been greatly impressed with the importance of this subject, but we have been unable to find that he ever conducted any experiments, or that he ever wrote anything which bore upon it, beyond an ironical imaginary correspondence between Fitch and Curtis (Practical Entomolgist, II, 54).

Professor Riley (3d Mo. Rept., p. 29) announced his intention of experimenting upon the transportation of the common parasite (*Sigalphus curculionis* Fitch) of the plum curculio (*Conotrachelus nenuphar* Hbst.) to different parts of the State of Missouri, but we are unable to find from his later reports if his intention was carried out. In conversation, however, he states that he did experiment successfully with this parasite.

With the parasites of bark-lice the matter of transportation becomes easy; since all that has to be done is simply to collect twigs bearing the scales, preferably during the winter months, in localities blessed with the parasite, in order to make sure of its presence. These twigs may then be carried to non-protected regions, the parasites being dormant and protected each by the scale of the louse it has destroyed. Arriving at their destination, the twigs should be fastened to infested trees. The result of the introduction can be ascertained from year to year by examining the scales upon the trees with a hand lens; such scales as are found to be pierced by a smooth round hole will have been destroyed by the imported parasite. Its increase and spread can be easily and accurately gauged in this manner.

Dr. Le Baron, in 1871–'72, conducted an experiment of this character with *Aphelinus mytilaspidis* Le B., the commonest parasite of the oyster-shell bark-louse of the apple (*Mytilaspis pomorum*, Bouché). A half-dozen twigs covered with scales, a few of which contained parasites, were transported during the winter from Geneva, Ill., to Galena, and there fastened to infested trees in three different orchards. At the end of a year evidence was obtained to show that the parasites had certainly become domiciled in their new quarters. That the result of this experiment was perceptible at all is a fact which, owing to the very small numbers of specimens imported, was hardly to be expected and which consequently augurs exceedingly well for the success of other experiments in this direction.

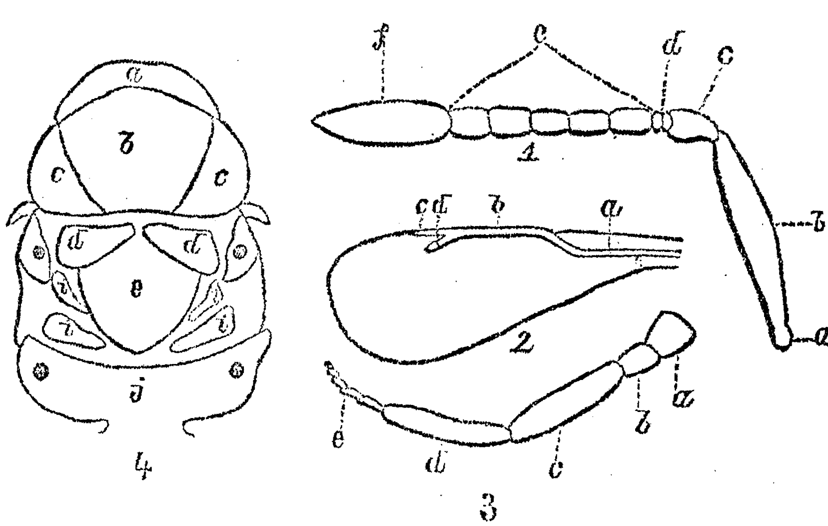
It is certainly strange that this line of investigation, which is so fascinating in its outlook, and which promises such important results, has not been followed up to some more definite conclusions for or against its practicability. As it is, the arguments are all in its favor, and the only difficulty is that we have not precedent. As stated before, we shall probably be able to attain the best results with the parasites of bark-lice on account of the great ease in collecting and transporting them while yet immature and enclosed within the scales of their hosts. As

will be seen from the detailed accounts of the species, which are to follow, the same species of parasite is not only not necessarily confined to a single and constant species of bark-louse, but is often found to infest species of even different genera. Hence, for example, it can be counted as among the probabilities that the very abundant and important parasite of the black scale of California (*Lecanium oleae* Bernard) which we have treated under the name of *Tomocera californica*, and which could be easily collected in great numbers on the Pacific coast, would destroy as well any or all of the closely related species of *Lecanium*, of which several are, or bid fair to become, injurious in parts of the South. This being the case, it would certainly be well worth while to attempt the importation of the California parasite.

With such possibilities as this, it becomes practically important, aside from the scientific interest attaching to such particulars, not only to fully describe all parasites of the group before us, but also to give as full details as possible concerning their life history and habits. With this view the following short paper has been prepared. In it will be found descriptions of all the bark-louse parasites contained in the department collection, and to each description are added such facts as our note-books furnish concerning the abundance and range of the species and the other points of interest. It is much to be regretted that these facts are so extremely meager, but it is hoped that this very fact will show to observers, more forcibly, perhaps, than in any other way, the field for work this direction.

It will be noticed that, with four or five exceptions, the species described are new to science. This is owing to the fact that almost no work has been done in this country upon the families Chalcididae and Proctotrupidae, to which all of these bark-louse parasites belong. The little that is published, having been written by men who were not specialists in the group, but who described simply for the purpose of making their papers upon noxious insects more complete, is naturally not of the highest order. This little paper, then, may also be considered an initiatory step to the study of the North American forms of these families, which we propose to make.

In order to explain the few terms which might otherwise prove incomprehensible to the non-scientific reader, we have introduced diagrams of an antenna, a wing, a leg, and the upper side of the thorax.



1. ANTENNA.—*a*, bulb; *b*, scape; *c*, pedicel; *d*, ring joints; *e*, funicle; *f*, club.
2. FORE WING.—*a*, submarginal vein; *b*, marginal; *c*, post marginal; *d*, stigmal.
3. FORE LEG.—*a*, coxa; *b*, trochanter; *c*, femur; *d*, tibia; *e*, tarsus.
4. UPPER SIDE OF THORAX.—*a*, pronotum or collar; *b*, mesoscutum; *cc*, mesoscutar parapsides; *dd*, scapulae; *e*, mesoscutellum; *iiii*, visible portions of metanotum.

The species to be described may be the more easily determined by the help of the following tables:

CHALCIDIDAE. ♂. Antennae always elbowed, with one or more ring joints between the pedicel and the funicle.
♀. The ovipositor arises below and anterior to the tip of the abdomen.
PROCTOTRUPIDAE. ♂. Antennae elbowed or not elbowed; no ring joint between pedicel and funicle; seldom with one small ring joint, but then not elbowed.
♀. The ovipositor issues from the tip of the abdomen.

CHALCIDIDAE.

The five subfamilies to be considered under this family may be separated as follows:

A. Tarsi 5-jointed.
 a. Middle tibiae with a very stout spur at tip.
  a. Antennae not more that 8-jointed........................APHELININAE.
  b. Antennae more than 8-jointed........................ENCYRTINE.
 b. Middle tibiae without a stout spur at tip........................PIRENINAE
B. Tarsi 4-jointed.
 a. Marginal vein extending past the middle of the wing..........ENTEDONINAE.
 b. Marginal vein not extending past the middle of the wing.TETRASTICHINAE

Subfamily APHELININAE.

As the most important of the bark-louse parasites are included among the *Aphelininae*, we shall discuss this group first. It is a subfamily of small extent, the number of species described in Europe not exceeding thirty; but all, with a few exceptions, pass their early stages as parasitic upon some bark-louse, the exceptions preying upon the allied group of *Aphididae* or plant-lice.

The two genera of this subfamily to which all of our species belong may be easily distinguished as follows:

A. Fore wings with a delicate hairless line commencing at stigma and extending obliquely toward base of wing........................APHELINUS Dalm.
B. Fore wings with no oblique hairless line........................COCCOPHAGUS Westw.

Genus APHELINUS Dalm.

Antennae 8-jointed; joint 1 (scape) quite long and slender; joint 2 large, subconical; joints 3 and 4 very small; joint 5 as long as or longer than 2, and subcylindrical; joints 6, 7, and 8 compacted into a large club; joint 8 at tip with several minute bristles, only seen with a high magnifying power. Mesoscutum wider than long, parapsides distinctly separated, small. Mesoscutellum very broad and short; subfusiform (except in *A. abnormis*, where it is pointed anteriorly), unicolorous. Middle tibial spur long, slender, as long as first tarsal joint. Fore wings each with an oblique hairless line extending from the stigma backwards to the posterior border of the wing, at a point little more than half way from the base to the stigma; the remainder of the wing, except near the base, with equally distributed pile; stigma small and inconspicuous, club-shaped, rounded at tip. Species generally unicolorous, either blackish or yellow, very seldom metallic.*

*The genus *Aphelinus* was founded by Dalman in 1820 as an offshoot of *Entedon*. In 1833 Westwood founded the genera *Coccophagus* and *Agonioneurus*, *Aphelinus* having contained species of each. In 1834 Nees ab Esenbeck founded the genus *Myina*, which corresponds exactly to *Agonioneurus*. In 1839 Walker, in his Monographia Chalciditum, placed both of Westwood's genera together under *Aphelinus*, but in 1846 separated from

1. A. MYTILASPIDIS Le Baron (Plate XXIII, fig. 1).

Female.—Length, 0.64mm; wing expanse, 1.28mm; greatest width of fore wing, 0.22mm. Head, thorax, and abdomen subequal in width; length of antennae equals width of head; thorax somewhat shorter than abdomen. General color bright lemon-yellow; scape, pedicel, and sometimes joints 3 and 4 of the antennae dusky, club yellow; eyes blackish, ocelli carmine; mandibles brown; all legs yellow; wing veins bright yellow. Wings delicate and hyaline, sometimes with a light shade of yellowish.

Male.—The male, which was unknown to Le Baron, is so similar to the female as to be absolutely indistinguishable from it unless the genitalia be carefully examined. The males will average somewhat smaller in size, and the club of the antennae is somewhat more truncate at the tip.

Described from many ♂ ♁ specimens.

The species is parasitic upon—

Mytilaspis pomorum, Bouché, Illinois, (Le Baron) Missouri, (Riley) New York? (Fitch) California.

Chionaspis pinifoliae Fitch, Missouri,? (Riley) D. C.

Mytilaspis on *Ptelia trifoliata*, (?) D. C. But one specimen was bred, and this was so much damaged that we cannot say with absolute surety that it belonged to this species.

Diaspis carueli Targ. on juniper, District of Columbia.

Mytilaspis sp. on linden, District of Columbia.

This parasite was first described by Le Baron in the American Entomologist, vol. ii (1870), p. 360, and afterwards treated of in his first report as State entomologist of Illinois (1871), p. 34, and by Riley (5th Missouri Report, p. 88). Our observations would seem to confirm Dr. Le Baron in the supposition that there are two broods of the chalcid in the course of a year, the insect wintering as a full-grown larva or pupa under the scales, and making its exit in the spring through the customary round smooth hole in the top of the scale. The second brood of parasites issues in August and September. The parasitic larvae when full grown are nearly 1mm long, very stout, almost as broad as long, rounded behind and slightly pointed before and of a light yellowish color. The dividing lines of twelve segments can be seen with some difficulty. There is never more than one larva found under a single scale. The pupa is dusky, and stout and contracted. I have not seen the egg after deposition, but those observed in the bodies of the females are globular, of a bright orange color, and of an average diameter of .0085mm. The larvae feed preferably upon the eggs of the coccids, but also devour the females.

The round holes through which these parasites make their exit from the scales were noticed by Fitch and figured by him on page 35 of his first report (1855). He also found the larva beneath the scale devouring the eggs. Walsh also observed these same holes (First Illinois Entom. Report, 1867, p. 45), but the adult was not discovered before Le Baron's experience with it in 1870. The figure illustrating his article in the American Entomologist, and also in his report, is very good so far as it goes, but no attempt has been made to show the parts of the thorax, and the spurs upon the middle legs are not given sufficient prominence.

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this genus Westwood's *Coccophagus*. Förster arbitrarily threw out *Aphelinus* on account of its poor definition and *Agonioneurus* on account of its length, and held to *Myina*. Thomson (the latest author) restores Dalman's genus and calls the tribe *Aphelinina*. In this we follow him and place *Agonioneurus* and *Myina* as synonyms of *Aphelinus*. Snellen van Vollenhoven in his "Schetsen", Pl. VII, has a figure of the parts of "*Agonioneurus* Westw. (*Myina* Nees)" in which the middle tibia is represented as having two very small apical spurs, and the posterior tibia a large branched spur. This is evidently a mistake as Westwood distinctly says "spur of middle legs large"; and Nees: "Pedes structurae communis."

A very good idea of the great importance of the work of this parasite may be readily gained from a glance at the following table, compiled from Le Baron's three tables.

A number of twigs were taken from apple trees in different gardens in Kane and Du Page Counties, Northern Illinois, in September and October.

Whole number of scales	844
Number with round holes through which *A. mytilaspidis* had escaped	289
Number having parasitic larvae under them	244
Number destroyed by mites or unknown cause	254
Number of sound scales	57
Whole number	844

This table shows that our parasite alone destroyed a little more than 63 per cent. of the whole number of scales and not quite 68 per cent. of the whole number destroyed by all causes whatever, thus showing it to be by far the most important factor in determining the abundance of the apple-tree bark-louse.

With the pine Mytilaspis we have never found the per centage of parasitization so great; still, the little chalcids are very abundant upon infested pines, and a large number of scales appear pierced.

It was with this parasite that Le Baron's experiments on the transportation and introduction of parasites were performed, as detailed in the introduction to this paper.

2. A. DIASPIDIS new species.

Female.—Length, 0.78^{mm}; wing expanse, 1.89^{mm}; greatest width of fore wing, 0.27^{mm}. Head, thorax, and abdomen usually equal in width, abdomen occasionally the widest. Antennal length equals width of head. The incision between joint 5 of the antennae and the club not well marked, joint 5 apparently forming part of the club. Color, dull yellow; eyes, black; ocelli, very dark red; antennae, dusky, darker at tip; a narrow dark transverse line on the occiput behind the eyes; femora and tibiae fuscous, tarsi nearly white; wing veins fuscous. Abdominal segments 1 to 5 have each a dusky transverse dorsal band interrupted towards the middle (these bands are resolved into dusky hairs under higher power). Wings clear with the exception of a delicate dusky patch below stigma. ♂ resembles the ♀ in all respects, except that the antennae club is distinctly 3-jointed, and the base of the abdomen is darker than in the ♀.

Described from 9 ♀ specimens, 2 ♂.

This species is parasitic upon *Diaspis rosae* Sandberg. Nine females and two males were bred, February 20, 1880, from a number of the scales of this insect collected at Fort Reed, Fla., by Col. B. F. Whitner. Two females were also bred from scales of *D. rosae*, on blackberry collected by Mr. T. C. Chamberlain, at Santa Barbara, Cal.

3. A. ABNORMIS new species.

Length, 0.55^{mm}; wing expanse, 1.4^{mm}; greatest width of fore wing, 1.23^{mm}. Proportions as in the preceding species. Scutellum sharply pointed anteriorly (in this respect differing from all other species of Aphelinus with which we are acquainted). General color, light lemon yellow; antennae dusky, eyes blackish, ocelli reddish, legs with yellowish femora and dusky tibiae and tarsi. Wings perfectly clear, veins transparent.

Described from 1 ♀ specimen.

Parasitic upon Mytilaspis sp. on *Salix caprea* (District of Columbia).

The peculiarity of the scutellum may ultimately cause this species to be referred to a new genus, but since it is so evidently closely related to Aphelinus in other respects, it seems best to place it here.

4. A. FUSCIPENNIS new species.

Length of body 0.06^{mm}; expanse of wings, 1.3^{mm}; greatest width of fore wing, 0.2^{mm}. General color, dull honey yellow; antennae fuscous, almost black at tip; eyes blackish, ocelli dark crimson; a distinct transverse black band on the occiput behind the eyes; scutellum a little blackish, at tip; abdomen with five dusky transverse lateral bands; legs and wing-veins honey yellow. Fore wings with an indefinite fuscous patch below stigma, and another well-defined, darker, somewhat crescent-like streak near the base, convex proximally.

Described from 9 ♀ specimens; ♂ unknown, but in all probability it is very similar to the female.

This species is parasitic upon—

Mytilaspis sp., on pear (San José, Cal.).
Mytilaspis sp., on Euyonymus (Fort George, Fla.).
Mytilaspis sp., on orange (District of Columbia).
Mytilaspis sp., on horse-chestnut (District of Columbia).

This seems to be a very widely-spread species. It comes nearer to *A. diaspidis* than to any of the other species, but seems well separated by its size and the distinctness of the fuscous wing patches.

5. A. PULCHELLUS new species.

Female.—Length, .09^{mm}; wing expanse, 2^{mm}; greatest breadth of fore wing, 0.38^{mm}. Head and thorax quite uniformly punctured, mesoscutellum rather more coarsely than other parts. Mesoscutellum more pointed at tip than in other species, and scapulae smaller; postscutellum very sharply pointed. Color: head and thorax white, tinged in spots with pale orange, except sides of metathorax, which are blackish; eyes bluish white; antennal scape white; pedicel dark brown at basal half, remainder white; joints 3 and 4 (annular) dark brown; joint 5 dark brown at base, rest white; club dark brown; all femora and tibiae grayish-white, spotted profusely with black; front tarsi whitish; middle tibial spur black; first two and last tarsal joints black; third and fourth yellowish; hind tarsi same as middle; fore wings whitish with an open net-work of fuscous; the hairs upon the fuscous portion are very strong and black, upon the remainder small and white; the clear oblique line is narrow; hind wings perfectly hyaline; abdomen dusky, nearly black above, orange colored with black at the junctures of the segments upon the sides; ovipositor black.

Described from 1 ♀ specimen; ♂ unknown.

Parasitic upon *Asterodiaspis* sp., on basswood (District of Columbia).

This species is the most beautiful I have ever seen. The shape of the scutellum and parts of the metathorax differ considerably from those figured of *A. mytilaspidis*, but not enough so but that it may properly be placed with Aphelinus.

6. A. MALI (Haldeman).

Length, 1.2^{mm}; expanse of wings, 2.3^{mm}; greatest width of fore-wings, 0.41^{mm}. Thorax slightly wider than head or abdomen; antennae somewhat longer than the head is wide; joint 5 very distinctly separated from the club; joints 3 and 4 proportionately longer than in the former species. Abdomen subconical. General color dark brown, nearly black; basal segment of abdomen yellowish; antennae with brownish scape and pedicel, and light yellowish flagellum; anterior femora white, banded with black in the middle; tibiae and tarsi yellowish white; middle femora black, base and apex whitish; tibiae black, yellowish at apex; tarsi yellowish; hind femora white, tibiae dark brown, tarsi brown, first joint darkest; wing-veins slightly yellowish.

Described from 6 ♀ specimens; ♂ unknown.

Parasitic upon *Schizoneura* (*Eriosoma*) *lanigera* Hausm., Pennsylvania, (Haldeman) Illinois, (Walsh) Missouri, (Riley) District of Columbia.

Although this species is not known to be parasitic upon any true coccid, I have introduced this description as it is the only known N. A. member of the tribe Aphelinina not known to be parasitic upon a member of this family, in order to complete the list of the species, and also in order to call attention to the fact that the genus *Eriophilus*, as founded by Haldeman in 1858,* is simply a synonym of *Aphelinus*.

* Proc. Bost. Soc. Nat. Hist. VI, 402. The description was previously published in the Farm Journal, 1851, pp. 130, 131.

The species is a very common one, and is the most important of the enemies of the woolly apple-louse.

NOTE.—Inasmuch as Mr. W. H. Ashmead has published a bark-louse parasite under this genus* as *Aphelinus aspidioticola*, it may be as well to state here that, from both figures and descriptions, the species of which he treats shows no relationship to Aphelinus, but evidently belongs to the proctotrupid sub-family Mymarinae.

Genus COCCOPHAGUS Westw.

Antennae 8-jointed; scape rather short and stout; pedicel one-third the length of scape and of about the same thickness; joints 3, 4, and 5 increase very slightly, or not at all in thickness and decrease in length; club very plainly 3-jointed and a little longer than the preceding two joints. With the ♂ the club is often less compact than with the ♀, and is narrower. Mesoscutum large, its posterior border with a slight reëntering angle; the sutures between the parapsides and scapulae very oblique. Mesoscutellum nearly as long as broad, rounded behind, the fore part forming three sides of a hexagon, the side bordering upon the scutum being a little shorter than the other two. The parts of the metanotum upon profile appear as three subequal bands. Wings equally hairy, except just at base; no hairless line. Stigma small, but usually colored so as to be plainly seen, subtriangular in form. Middle tibial spur usually not as long as first tarsal joint, usually curved. Species usually of somber colors, often with two contrasting colors—black and yellow.†

7. (1) C. LECANII (Fitch).

Female.—Length, 0.9^{mm} to 1^{mm}; average wing expanse, 2.25^{mm}; greatest width of fore wing, 0.42^{mm}. Antennae as long as the thorax. Head, pronotum, and mesoscutum finely punctured and covered with minute bristles. Scutellum nearly smooth, and with but the normal four large bristles; abdomen smooth and shining, very concave above in dry specimens. General color black; eyes (in death) dark reddish brown; antennae light brown, with dark longitudinal carinae on each joint, except scape and pedicel; tip of club darker; last half of mesoscutellum, and tip of metascutum bright lemon-yellow; wing-veins dark brown; all femora brown, yellowish at either extremity; all tibiae straw-yellow, with the exception of the posterior pair which have each a brown annulus near base; all tarsi light yellow with their fifth joints dark brown.

Male.—Length of body, 0.52^{mm}; expanse of wings, 1.1^{mm}; greatest width of fore wings, 0.21^{mm}. Abdomen small, much narrower than thorax. Antennae longer than thorax. Color like that of the female, except that the scutellum is of a uniform brown.

Described from 10 ♀♀, 1 ♂.

Parasitic upon—
Lecanium quercitronis Fitch, N. Y. (Fitch).

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* See Canadian Entomologist, vol. XI, p. 150. See also "Orange Insects," Jacksonville, Fla., 1880, p. 7, Pl. II, Figs. 1, 4, 7, 9, 13.

† As before stated Coccophagus was founded by Westwood in 1833. It was adopted by Nees, 1834, in his addenda to vol. ii, Hym. Ichn. Af. and overlooked by Walker in his Monogr. Chal., 1839; adopted, however, by the latter in 1846. In 1852, Ratzeburg founded the genus Coccobius (Ichn. d. Forstins, iii, 195). This Walker considered as synonymous with Coccophagus, as I see by unpublished MSS. notes in my possession, and he probably transmitted this opinion to Snellen van Vollenhoven, as in the latter's plates (Schetsen, &c., tab. vii), he has copied Ratzeburg's figure with no other inscription than "*Coccophagus* Westw." Now the illustration shows what is evidently the antennae of Aphelinus, while among the species described under Coccobius are a few which seem to belong to Coccophagus, notably *C. notatus*.

Pulvinaria innumerabilis (Rathvon), Illinois (Miss Smith), District of Columbia.

Lecanium hesperidum (Linn.). On ivy, District of Columbia; on orange, Los Angeles, Cal.

The specimens bred from *L. hesperidum*, at Washington, were a little smaller than those bred in California, and the yellow crescent was of hardly so brilliant a shade of color, yet it is impossible to separate them into two distinct species. With the Washington variety these chalcids seem only to infest the smaller or half-grown females of the bark-lice, which show the presence of the parasite, as it nears the completion of its development, by turning black. The larger full-grown females seem to be exclusively infested by another parasite (*Comys bicolor*), which will be treated later in this paper. We have never bred more than one specimen of *Coccophagus lecanii* from a single Lecanium, but Professor Comstock has brought from California, among other specimens of this bark-louse, two which had been pierced with two and three holes respectively, showing the presence of as many chalcids.

This parasite was first described by Fitch (Fifth N. Y. Rept., p. 25) as feeding upon an oak scale insect which he named *Lecanium quercitronis*. He erroneously stated the parasite to belong to the family Proctotrupidae, and placed it in the genus Platygaster. His description is quite full and accurate. In the Seventh Report of the Illinois State Entomologist, published 1878, Miss Smith, in an article on the cottony maple scale, mentioned the breeding of a chalcid parasite, and quoted Fitch's description as being of a similar insect; but, she says, speaking of the parasite she had bred, "Instead of it belonging to the proctotrupidae family, it belongs to the chalcididae. I therefore record it as a new species." This species she published in the Am. Nat., 1878, p. 661, as *Coccophagus lecanii* n. sp. The idea that Fitch had made a mistake seems not to have suggested itself to her.

This parasite is stated by Miss Smith to be very abundant in Illinois upon the females of Pulvinaria, occurring always singly, and appearing as an adult twice in the course of a year, the second brood in August and the first presumably in early spring. The species is not abundant in Washington, as the Pulvinaria is very rare, presumably from the presence of the predaceous pyralid—*Dakruma coccidivora* Comstock.

8. (2) C. IMMACULATUS new species.

Female.—Length, 1.2^{mm}; wing expanse, 2.35^{mm}; greatest width of fore wings, 0.47^{mm}. Antennae slightly longer than thorax. General color, black; eyes, reddish brown with a yellowish border above; ocelli, dark red; antennae, light yellowish brown, with dark brown longitudinal carinae on each joint, except scape and pedicel; mesoscutellum shining black, slightly metallic in some lights; wing-veins dark brown; front femora black, middle and hind femora black, except at base, which is whitish; front tibiae dusky, light at knees; middle and hind tibiae light yellow; front tarsi fuscous, last joint darkest; middle and hind tarsi whitish, last joint fuscous; front coxae dark brown, middle and hind coxae yellowish; ovipositor yellow, sheaths brown.

Male.—Length, 0.9^{mm}; wing expanse, 2.3^{mm}; greatest width of fore wing, 0.43^{mm}. Antennae as long as thorax, club compact, the lines separating the joints of the club somewhat oblique. Colors as with ♀.

Described from 1 ♂, 3 ♀ ♀.

Parasitic upon *Eriococcus azaleae*, District of Columbia.

This parasite was bred from specimens of the Eriococcus found on the azalea in the department greenhouse. One parasitized louse opened showed that the skin of the dead bug (turned brown in color) lay loose under the white crust, and resembled more the cocoon of a hymenopterous parasite than the skin of the former insect. Within this skin was

found the black pupa of the parasite. The adult chalcid made its exit through a round hole cut in the back of the louse. None of the parasited lice were found to contain more than one chalcid. A few day later a specimen was found containing the larva of the chalcid. It was evidently full-grown and measured 1.3^{mm} (.05 inch) in length. It was one-third as thick as long, and tapered toward each end, the head end being larger than the other. It seemed that its natural position was curved with its dorsum considerably arched. The color was white, with the dark alimentary canal showing through the skin. During the spring quite a number of the pierced skins were found in the department greenhouses, and the parasite would thus seem to be tolerably common. Thriving, as it does, in greenhouses, this chalcid will doubtless afford a good opportunity for experimentation in the way of encouraging its reproduction and of transporting it from one locality to another.

9. (3) C. FUSCIPES new species.

Female.—Length, 1^{mm}; wing-expanse, 2^{mm}; greatest breadth of fore wing, 0.36^{mm}. Antennae slightly longer than thorax. General color, rather dark brown; eyes blackish; antennae light brown, with brown longitudinal carinae on each joint, except scape and pedicel; mesoscutellum dark brown, light yellow-brown at tip; all coxae, femora and tibiae fuscous, whitish at tips; last joint of all tarsi dark, the preceding joints lighter, but still with a dusky tinge; wing-veins dusky, those at the fore wings darker than those of the hind.

Male.—Length, 0.8^{mm}; wing expanse, 1.8^{mm}. Antennae, equal in length to head and thorax together; club long, each of its three joints as long as the immediately preceding flagellar joints. Coloration identical with that of the female, except that the yellow-brown tip to the mesoscutellum is wanting.

Described from 1 ♀, 3 ♂ specimens.

Parasitic upon *Lecanium* sp., on Magnolia, Florida.

10. (4) C. COGNATUS new species. (Plate XXIII, Fig. 2.)

Female.—Length, 1.2^{mm}; wing expanse, 2.1^{mm}; greatest breadth of fore wing, 0.34^{mm}. Antennae not quite so long as thorax. General color, dark-brown, nearly black; last half of mesoscutellum and tip of metascutellum, orange-yellow; anterior coxae, femora and tibiae fuscous, tarsi whitish, last two joints slightly dusky; middle femora and coxae nearly black, tibiae somewhat dusky, tarsi as with fore tarsi; hind coxae, femora and tibiae dark, tarsi as with others.

Male.—Length of body, 0.6^{mm}; expanse of wings, 1.4^{mm}; greatest breadth of fore-wing, 0.25^{mm}. Antennae nearly as long as head and thorax together. General color, brown; scutellum and metascutellum just tipped with light yellow-brown. In all other respects resembles the female.

Described from 8 ♀, 3 ♂ specimens.

Parasitic upon *Lecanium hesperidum*, Linn, on orange trees in orange house of Department of Agriculture, District of Columbia.

11. (5) C. FRATERNUS new species.

Female.—Length of body, 0.78^{mm}; expanse of wings, 2^{mm}; greatest width of fore wing, 0.36^{mm}; general color, deep dead black; tip of mesoscutellum bright yellow, the line of juncture of the two colors on the scutellum being very uneven; tip of metascutellum also yellowish; all coxae and femora black, whitish at tips; all tibiae dark brown in the middle, whitish at either end; all tarsi whitish, dusky as to the last two points; middle tibial spur white; wing veins dark brown.

Described from 12 ♀ specimens; ♂ unknown.

Parasitic upon *Lecanium* sp., on peach, District of Columbia.

12. (6) C. ATER new species.

Female.—Length, 0.65^{mm}; expanse of wings, 1.4^{mm}; greatest width of fore wing, 0.3^{mm}. Color jet black with slight purplish reflections; antennae light brown; wing-veins brown; all coxae, femora and tibiae brown, light at joints; tarsi yellowish, last joint dusky.

Male.—Similar in all respects, but slightly smaller.
Described from 1 ♂ 1 ♀.

Parasitic upon *Lecanium* sp., on maple, Ithaca, N. Y.

13. (7) C. VARICORNIS new species.

Female.—Length, 0.7mm; expanse of wings, 1.4mm; greatest width of fore wing, 0.25mm. Color black; scape of antennae slightly widened, dusky; pedicel small, nearly white; first funicle joint large, dark brown; joints 2 and 3 of the funicle white; club light-yellow brown, as long as the two preceding joints together. The abdomen and thorax at the point of juncture lighter than elsewhere; all coxae whitish; all femora and tibiae very dark brown, light at the tips; all tarsi whitish except the dark last joint; wing-veins light yellowish; ovipositor brown.
Decribed from 1 ♀; ♂ unknown.

Parasitic upon *Aspidiotus* sp., on linden, District of Columbia.

Subfamily ENCYRTINAE.

Tarsi 5-jointed; middle tibiae somewhat dilated towards tip, and furnished with a long stout spur; antennae more than 8-, usually 11- or 10-jointed. Parapsides of mesoscutum not separated by furrows; mesothorax prominent, broad in the middle; vertex with an acute occipital margin;* abdomen usually short and sessile.

The members of this tribe are small, active chalcids, which, while by no means confined to coccids as hosts, still are much more often parasitic upon insects of this family, than upon those of any other. Dr. Mayr, in his paper upon the European Encyrtinae (Verh. d. Zoöl. Bot. Ges. Wien 1875, p. 681) tabulates the species according to their hosts, and we may briefly condense by saying that one species is parasitic upon an hymenopterous insect, two upon coleoptera, four upon lepidopterous eggs, sixteen upon lepidopterous larvae, four upon diptera, while forty species are parasitic upon hemiptera, of which thirty-nine infest bark lice, the remaining one being found upon two species of aphides.

Ratzburg (Ichn. d. Förstins, III) mentioned two species of Encyrtinae parasitic upon hymenoptera, four on coleoptera, four on diptera, twelve upon lepidoptera, and no less than twenty-five upon hemiptera.

Even these facts, however, cannot be taken as fairly indicating the proportion of these insects which are parasitic upon the Coccidae, since the latter family has been heretofore so little studied in comparison with other groups, that doubtless many of its parasites have never been reared. When as much biological work shall have been done upon it as, for instance, upon any one of the families of lepidoptera, we may expect to find that the proportion of Encyrtinae parasitic upon insects of other families will become dwarfed in comparison.

The six genera of Encyrtinae represented among our coccid parasites may be distributed as follows. The table applies only to *females:*

A. Funicle 5-jointed .... RHOPUS Först.
B. Funicle 6-jointed.
  a. Scutellum with a terminal tuft of long stiff hairs.
    a. Pedicel shorter than the first funicle joint; mesoscutum without silvery white hair; marginal vein shorter than stigmal .... COMYS Först.
    b. Pedicel longer than first funicle joint; mesoscutum with short silvery white hair; marginal vein at least as long as stigmal. CHILONEURUS Westw.
  b. Scutellum without a tuft at tip.
    a. Mesoscutum and scutellum lusterless.
      * Funicle joints thicker than long; marginal vein wanting, APHYCUS Mayr.
      * * Funicle joints longer than thick; marginal vein present. BLASTOTHRIX Mayr.
    b. Mesonotum and scutellum lustrous .... ENCYRTUS Dalm.

*Walker's translation of this last character from Förster's "Der Scheitel hinten scharf gerandet" is very indefinite and misleading—"disk strongly bordered behind."

Genus RHOPUS Först.

Female.—Antennae 10-jointed, inserted very near the mouth; scape rather thick, moderately compressed, reaching almost to the top of the head; the pedicel rather large, somewhat more than double as long as thick, and at the end thicker than the first funicle point; the ring joint is only to be seen with fresh specimens, and then only with a high magnifying power; the funicle is only 5-jointed, the first joint as long as thick, the second and third somewhat thicker than long, the fourth and fifth as long as thick, the joints increasing in size from the first to the fifth; the club is rather large, cylindrical, with a somewhat conical ending, as long as or longer than the last four funicle joints together, somewhat wider than the fifth, and bears no trace of joints (except with a strong microscopic power). The head is small; clypeus somewhat large, moderately arched; the vertex is broad and the ocelli form the corners of a very obtuse angled triangle; the occipital edge is sharp but is not easy to see, as the head is customarily shriveled or cracked.

Head, mesoscutum, and scutellum are shining, and all extremely delicately shaggreened and finished with very fine hairs. Five joints are perceptible on the upper side of the abdomen, of which the first four are nearly of the same size, while the last is larger and smooth. Wings ciliated and with a short sub-marginal vein, so that more than the distal half of the wing is veinless; the marginal vein is very short, the stigmal longer (often indistinguishable on account of its clear color), and the post marginal very short; the ovipositor is scarcely observable.

Male.—Similar to the female and (so far as the study of dry specimens allows one to judge) almost only to be distinguished through the antennae. These are much longer and 11-jointed; the scape is the same as with the female; the pedicel is about one and a half times as long as thick, and somewhat shorter than the first joint of the funicle; the funicle is long, 6-jointed, thickly covered above with long upright hairs, which are about as long as the joints and arranged in two half whorls on each joint; the funicle joints are sharply separated from one another, of about equal length, and about half as thick as long; the club is cylindrical and rounded at tip, is not thicker than the sixth funicle joint, and is somewhat shorter than the last two together. The abdomen appears on the upper side to be composed of only two large joints, and is rounded at the hinder end. The sub-marginal vein is somewhat longer than with the female.*

The following species—*R. coccois*—was made the type of the new genus *Aecrophagus* by Miss Emily Smith (N. A. Entomologist, I, p. 83). There seems, however, to be no valid reason for separating this species from *Rhopus*. The few points of discrepancy are not sufficient to characterize a new genus, and are, without doubt, due to the fact that *Rhopus* was founded upon a single species, and naturally the characters may be expected to be slightly modified by the discovery of additional species. The European species (*R. testaceus*, Ratz. Ichn. d. Förstins, II, 1848, p. 146) lives upon *Lecanium racemosus*, Ratz.

14. (1) R. COCCOIS (E. A. Smith). (Plate XXIV, Fig. 2.)

Female.—Length, 0.55^{mm}; wing expanse, 0.92^{mm}; greatest width of fore wing, 0.16^{mm}. Joints of the funicle subequal in length, the first and second being slightly shorter, and all increasing in width from the first to the fifth; club as long as the whole funicle,

* The genus *Rhopus* was founded by Förster in 1856. The above full description of the genus is taken for the most part from Dr. Mayr's "Europaïschen Encyrtiden" (Verh. d. Zoöl. Bot. Ges., 1875, p. 690).

and with the lines of division into three joints perceptible with a high power. Color, yellow, the head darker than the rest; wings, hyaline; veins, colorless.
Described from 1 ♀; ♂ unknown.

Parasitic upon *Pseudoccus aceris*, Geoff, on hard maple, Peoria, Ill. (Miss Smith); Lancaster, Pa. (Dr. Rathvon).

According to Miss Smith, the eggs of this parasite are only laid in the female lice when they have attained full growth and are ready to begin ovipositing. From six to twelve eggs are laid in a single host.

Genus COMYS Förster.

Antennae rather long, 11-jointed, the pedicel slightly shorter than the succeeding joints; from joint 3 the joints of the flagellum gradually decrease in length; with the female they become more and more compressed towards the tip of the club, with the male remaining subcylindrical. The head and face are coarsely punctured. The scutellum is three-cornered, with a somewhat rounded tip; near the tip is a tuft of erect, long, stiff, dark hairs. The ovipositor is entirely or almost entirely hidden. The fore wings are brownish on the distal half, and the nearly clear basal half has a brownish cross streak. The marginal vein is very short, the post marginal and stigmal long. The males are very similar to the females, the antennal characters giving the only absolute distinction. The wings are sometimes clear and sometimes slightly brownish as with the female*.

15. (1) C. BICOLOR, new species. (Plate XXIII, Fig. 3.)

Length of body, 1.75mm; expanse of wings, 2.9mm; greatest width of fore wing, 0.55mm. Color: eyes, dark brown; face and head, yellow brown; cheeks below the eyes blackish; palpi, black; antennal scape silvery white below, black above; flagellum black, with many short black hairs; collar shining black; remainder of thorax yellow brown with black hairs; scutellar tuft thick, strong, and black, apparently arising in two short, longitudinal, closely approximate rows; abdomen, shining black with sparse long black hairs; anterior femora, white below, fuscous above, especially towards knee; tibiae and tarsi, dark brown; middle femora white below, fuscous above; tibiae, tibial spur, and tarsi, brownish yellow; posterior femora and tibiae, dark brown, nearly black; base of first tarsal joint black; rest, silvery white. Distal two-thirds of wing dusky, with a short hyaline wedge-shaded band at the end of the marginal vein; at the juncture of the subcostal vein with the costa a broad, clear, hairless band extends back across the wing; the fringe of dark hairs upon the subcostal makes an abrupt downward bend at a little over half its length and becomes the proximal border of the hairless space for a little over half the wing width.
Described from 18 ♂ ♀ specimens.

Parasitic upon *Lecanium hesperidum* (Linn.), upon ivy; District of Columbia.

This species was found to be quite abundant, during the months of August and September, among the bark-lice upon the English ivy trained over the greenhouses of the department. While the smaller scales were infested by *Coccophagus lecanii* Fitch, the larger ones seemed to be the exclusive property of the *Comys*. The latter, from its size, naturally could only attain its growth in the largest lice, while the former seemed never to attack specimens which were larger than was absolutely necessary to afford them sufficient nourishment.

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*The genus *Comys* was founded by Förster in 1856. On pp. 32 and 34 (Hym. Stud. II) it is given as *Eucomys*; but in the "Nachtrag," p. 144, he changes the name to *Comys* on account of the similarity of the former name to *Eucomis*, a liliaceous genus of plants. Walker, however, in his notes (1871, p. 69) overlooks the change and uses the older name. Snellen Van Vollenhoven, in his "Schetsen," &c., Pl. VII, figures this genus, but, as pointed out by Mayr (Verh. d. Zoöl. Bot. Ges. Wien., 1875, p. 740), greatly exaggerates the length of the eyes, and leaves out one antennal joint, besides altering the relative proportions of the joints.

From the time of the depositing of the parasitic egg to the time when the larva has reached its full size, no change can be seen in the appearance of the *Lecanium;* but when the parasite changes to the pupa state the bark louse begins to appear black. At this time the infested lice may be readily detected at a glance. That this species also destroys the same scale on orange seems very probable from the fact that specimens have been found in spiders' webs on orange trees infested by *L. hesperidum*, although none of the lice have as yet been found to contain the parasites.

16. (2) C. FUSCA n. sp.

Male.—Length, 2.6mm; expanse of wings, 5mm; greatest width of fore wing, 0.8mm. Face deeply punctured, yellowish brown in color, vertex dusky, cheeks blackish, mouth parts dusky. Scape of antennae and pedicel honey-yellow below, brown above; flagellum blackish, with quite long black hairs. Collar black above, brownish-yellow below; mesoscutum blackish in the middle, ocherous at sides, clothed with many lighter hairs; tegulae ocherous, blackish at tip; scapulae dusky, very thickly and finely punctured; mesoscutellum ocherous with yellow hairs anteriorly, the tuft being black; metanotum black except postscutellum, which has an ocherous tinge; peduncle black; abdomen shining black. Wings as with *C. bicolor*, the markings, however, being clearer and more distinct, and the veins very black, except at the transverse clear spot; the stigmal vein is more curved than in *bicolor*. Front coxae transparent white, femora, tibiae, and tarsi honey-yellow; middle and hind coxae yellowish, blackish at tips; middle femora yellowish, slightly darker above; tibiae almost black, yellowish at tip; spur and tarsi yellowish; claws blackish; hind femora and tibiae nearly black; tarsi whitish except last joint.

Female similar to the male in all respects except that the color of the collar, mesoscutum, scapulae, and mesoscutellum is of a uniform clear ocherous.

Described from 1 ♂, 3 ♀ specimens.

Parasitic upon *Lecanium* sp., upon laurel leaved oak, collected at Mobile, Ala., by J. Parish Stelle.

Genus CHILONEURUS Westwood.

Female.—Antennae given off near the border of the mouth, 11-jointed; pedicel longer than the succeeding joint; the flagellum is cylindrical or somewhat flattened; club spindle-shaped or compressed. Vertex narrow; head and face not coarsely punctured. Mesothoracic scutum is covered with short, delicate, silver-white hairs, and the scutellum bears a tuft of long, black, stiff bristles. The ovipositor protrudes slightly. Marginal vein long; stigma and postmarginal very short.

Male.—Differs from the female principally in the antennae; the pedicel is scarcely longer than thick; the succeeding joints to the club are long, slender, distinct, and, with the exception of the first, are each contracted in the middle, and are finished above with two half whorls of long diverging hairs; the club is not thicker than the preceding joint, and is shorter than the two preceding joints together. The hairs upon the scutellum are more scattered than in the ♀ and not gathered together in a tuft.*

17. (1) C. ALBICORNIS new species. (Pl. 1, Fig. 4).

Female.—Length of body, 1.8mm; expanse of wings, 3.4mm; width of fore wing near tip, 0.7mm. Pedicel of antennae twice as long as wide; club much flattened, oval, as long as the preceding four joints. Abdomen acuminate at tip. Color: antennae, scape, and base of pedicel dark brown; apex of pedicel and all of succeeding joints except the club snow-white; club black; eyes black; ocelli dark red; head and face bright ferruginous; pronotum, mesothoracic scutellum, and scapulae ferruginous; meso-

*The genus *Chiloneurus* was founded by Westwood in 1833 (Phil. Mag. and Journal of Sci., III, p. 343). Snellen's illustration of this genus (Schetsen, &c., pl. VII) is thoroughly unreliable and misleading.

thoracic scutum blue black, with many fine closely laid silver-white hairs; metanotum black; abdomen black, with many black hairs; ovipositor yellow brown; front legs blackish above, yellowish below; tarsi yellowish brown; middle femora dark brown, light towards tip, tibiae white, tibial spur and tarsi yellowish; posterior legs dark brown, tarsi yellowish. Fore wing with a large dusky patch occupying its center, and with a broad excurved hairless band at the distal border of the patch; just below the marginal vein is a narrow, short, hairless line obliquing upwards and bordered by rather long inward directed hairs; at the distal end of the stigma and postmarginal is a narrow, short transverse clear line, extending one-fourth the distance across the wing; all veins brownish, marginal very dark, stigmal almost imperceptible.

Described from 2 ♀ specimens; ♂ unknown.

Probably parasitic upon *Lecanium* sp., on pine.

The two females in the collection were caught upon the leaves of *Pinus rigida* at Washington, which was infested both with *Chionaspis pinifoliae* (Fitch) and the *Lecanium;* but the former is apparently too small to support a parasite of the size of the *Chiloneurus.*

NOTE.—Since the above was written seven specimens of the female of this insect have been received from Mr. J. Duncan Putnam, of Davenport, Iowa, who bred them from specimens of *Lecanium caryae* Fitch in his collection.

A discrepancy will be noticed between the relative proportion of the length of the body to the wing-expanse as given in the text and as shown upon the figure. The explanation is that the measurements were taken and the species described from fresh specimens, while the drawing was made sometime afterwards and the body had shrunken considerably.

Genus APHYCUS Mayr.

Female.—Antennae, 11-jointed, moderately short, inserted near the mouth; scape widened or cylindrical; pedicel about twice as long as thick; the joints following the pedicel are thicker than long and increase in thickness by degrees; the club is about as long as the three preceding joints and is obliquely rounded, often compressed. Face, vertex, and dorsum of thorax are lusterless and finely punctate, frequently clothed with yellowish hair. Ovipositor usually not protruding. The marginal vein is not developed, and the stigmal is given off at the juncture of the subcostal with the costa.

The *male* is distinguished from the female by the antennae, in which the pedicel is longer than the succeeding joint (this is so also with the female but not with the males of allied genera). The flagellum is uniformly clothed with hairs; the first joints are longer than thick, and the club only so long as the two preceding joints.*

18. (1) A. ERUPTOR new species. (Plate XXIII, Fig. 5).

Female.—Length, 1.6^{mm}; expanse of wings, 2.9^{mm}; greatest width of fore wing, 0.4^{mm}. Antennal scape slender, cylindrical. Ocelli large, placed close together, and form a nearly equal sided triangle. Color: Eyes black, ocelli carmine; antennal scape blackish above, yellow below; pedicel blackish at base, yellow at tip, succeeding joints dusky to joint 7, which is yellowish at tip, joint 8 entirely yellow, and the club dark brown, nearly black; face and entire under surface of the body light yellow; legs dirty white, slightly yellowish; collar black, mesothoracic scutum and scutellum orange-yellow, the former dark anteriorly; abdomen dusky with an orange shade; wings clear. Ovipositor protrudes slightly.

Male.—Vertex, mesothoracic scutum, and scutellum and dorsum of abdomen dull blackish with short sparse griseus hairs. Antennae, with thick, short hairs.

Described from 1 ♂, 1 ♀.

*This genus was founded by Mayr in 1875 (Die Europäischen Encyrtiden, Verh. d. Zoöl. Bot. Ges. in Wien, 1875, p. 695). The three European species of the genus all live in bark lice.

Parasitic upon *Lecanium* sp., on Japan persimmon, oak, and crataegus, collected by Dr. R. S. Turner, at Fort George, Fla. This species was also collected by Mr. Th. Pergande in Northern Virginia.

19. (2) A. FLAVUS new species.

Female.—Length, 1.2mm; wing expanse, 2mm; greatest width of fore wing, 0.37mm. Antennal scape rather slender, somewhat broadened below on basal half; club slightly compressed, nearly as long as whole of funicle. Color, bright orange-yellow; eyes black; antennal scape with a dusky patch above; joints 1 and 2 of the funicle slightly dusky; basal half of the club dark brown; wings clear; veins yellowish.

Described from 1 ♀ specimen; male unknown.

Parasitic upon *Mytilaspis citricola* (Packard). Collected at Palatka, Fla., by Mr. J. H. Gates.

20. (3) A. PULVINARIAE new species.

Female.—Length, 1mm; wing expanse, 2.6mm; geeatest width of fore wing, 0.4mm. Antennal scape short, and with a broad leaf-like expansion below; club compressed, as long as the four preceding joints together. General color dull yellow; scape of antennae black, whitish at tip; pedicel black at base, rest yellowish-white; first three joints of the funicle dusky, the remaining yellowish-white; club dark brown, lighter at tip; metanotum and dorsum of abdomen dusky, nearly black. In all other respects similar to the preceding species.

Described from 3 ♀ specimens; male unknown.

Parasitic upon *Pulvinaria innumerabilis* Rathvon. Bred by Mr. J. Duncan Putnam, of Davenport, Iowa.

Genus BLASTOTHRIX Mayr.

Female.—Antennae 11-jointed, arising near the margin of the mouth; scape strongly or only moderately broadened below; pedicel from one and one-half to two times as long as wide, a little shorter or a little longer than the succeeding joint; the flagellum is wholly cylindrical, or the last joints are slightly compressed; all joints before the club are longer than thick, except that the eighth is sometimes as thick as long; the club is more or less compressed (only in death?), and is as long as, or somewhat longer than, the two preceding joints together, in the middle wider than the preceding joint, and at the tip rounded or blunted. Head and mesonotum delicately and sharply punctured and lusterless; mesonotum with short appressed yellow-white hairs; mesothoracic scutum, scutellum, and scapulae closely joined and forming a continuous, transversely-arched surface. The stigmal vein longer than the marginal.

Male.—The antennal scape is less compressed than with the female; the pedicel is scarcely longer than thick, and is much shorter than the succeeding joint; the joints between the pedicel and the club are strongly incised above at the articulations, and each joint bears upon its upper side two half-whorls of long, erect hair.*

21. (1) BLASTOTHRIX ADJUTABILIS new species. (Plate XXIII, Fig. 6.)

Female.—Length, 1.4mm; expanse of wings, 3.3mm; greatest width of fore wing, 0.35mm. Scape of antennae slightly widened below near its distal end; pedicel slightly longer than succeeding joint; joint 8 as broad as long; club compressed, rounded at tip. General color black; head, scutellum, and abdomen slightly metallic; antennae black, scape light brown; all coxae black; all femora black, light brown at tips; all tibiae blackish, yellow brown at tips, the hind tibiae being much blacker than the fore or middle; middle tibial spur and all tarsi honey-yellow. Wing-veins light brown; fore wings each with a dusky semicircular patch near tip, and

* This genus was founded by Mayr in 1875 (*ibid.*, p. 697). The European species are all supposed to live upon bark lice.

with a narrow, oblique, hairless line (reminding one of that characteristic of the genus *Aphelinus*) extending from stigma towards base.

Described from 5 ♀ specimens; male unknown.

Parasitic upon *Lecanium* sp., on Japan persimmon, oak, and crataegus. Collected by Dr. R. S. Turner, Fort George, Fla.

This species was also collected by Mr. Th. Pergande in North Virginia.

22. (2) BLASTOTHRIX INCERTA new species.

Male.—Length, 1.4mm; expanse of wings, 2.2mm; greatest width of fore wing, 0.4mm. Antennal scape very short and quite stout; joints 3 and 4 are of equal length; hairs in the whorls about twice as long as the individual joints. Wings entirely clear; marginal vein very short, almost entirely wanting; all veins colorless and difficult to distinguish. General color dark brown, nearly black. Head and mesonotum densely but finely punctured. Antennal scape and pedicel dark brown; remaining joints lighter. All coxae and femora brown, the anterior ones lightest and the posterior ones darkest; anterior tibiae light yellowish; middle and posterior tibiae dark brown, yellow-white at either extremity, the whitish ends being longer with the middle than with the hind; all tarsi whitish, with the apical claws brownish.

Described from 1 ♂ specimen; ♀ unknown.

Parasitic upon an unknown scale insect upon mesquit (a *Lecanium?*). Bred by Dr. R. S. Turner, at Fort George, Fla.

This insect may prove to be the male of the previous species, as it resembles it in most essential points and comes from the same locality, but for want of better proof I see no better course than to describe it as a distinct species, leaving it for future investigation to decide whether it shall stand or fall.

23. (3) BLASTOTHRIX LONGIPENNIS new species.

Female.—Length, 1.75mm; expanse of wings, 4.5mm; greatest width of fore wing, 0.85mm. Scape of antennae strongly widened vertically. Shining black in color, bulb brown; pedicel longer than the first funicle joint, and with the club, and joints 1, 2, 3, and 4 of the funicle, is black; joints 5 and 6 of the funicle cream white; club oval, somewhat compressed and somewhat longer than the two preceding joints together. The ocelli are at the angles of a nearly righ -angled triangle. Head greenish above, bluish around mouth; dorsum of thorax metallic green; tegulae whitish, brownish at tip; pleurae bright green, whitish at posterior border; abdomen greenish above, bluish below; fore and hind femora metallic green, white at tips; middle femora light brown, white at tips and with a distinct dark patch below at distal end; front and hind tibiae black with a slight greenish tinge, yellowish at distal end, white at proximal; middle tibiae yellowish with two black bands, white, however, at proximal end; all tarsi yellowish white, last joint darker. Wing-veins distinct and dark brown in color, the post-marginal longer than the marginal and about equal in length to the stigmal.

Described from one ♀ specimen; ♂ unknown.

Collected by Mr. Th. Pergande in the District of Columbia. It is, of course, not known upon what this chalcid is parasitic; but, from the uniformity of habit among the known members of the genus, it may safely be put down as a coccid destroyer; hence it has been thought proper to introduce the above description.

Genus ENCYRTUS Dalman.*

Female.—Antennae 11-jointed, inserted not far from the border of the mouth, moderately thick, and, with the exception of the scape, very seldom compressed; the scape is often strongly broadened; the club is rounded or with a slight oblique truncation at tip. The facial impres-

*The genus *Encyrtus* was originally founded by Latreille in 1809 (Gen. Crust. et Ins. IV, p. 31), but was first applied to insects now recognized as *Encyrtinae* by Dalman, who (Vet. Ac. H. 1820) described many species.

sion is rather large and often quite deep. The mesonotum is transversely arched, shaggreened and more or less lustrous; the scutellum shows a different sculpture. The wings are always developed and ciliated; the marginal vein is present, seldom very short; the stigmal is moderately long. The ovipositor not as long as half the abdomen.

Male.—The flagellar joints are slightly or not at all compressed, and covered equally (not in half-whorls) with hairs.

24. (1) ENCYRTUS FLAVUS new species. (Plate XXIII, Figs. 7 and 8.)

Female (Fig. 8).—Length, 1.2mm; expanse of wings, 3mm; greatest width of fore wing, 0.4mm. Antennal scape somewhat widened below; pedicel somewhat longer than the following joint, one and one-half times as long as wide; flagellum subcylindrical, the joints increasing very slightly in diameter towards club, and decreasing gradually in length; club slightly compressed and slightly truncate at tip, as long as the preceding three joints. The vertex is narrow and the ocelli form an acute-angled triangle. The marginal vein is short, the stigmal being long; the basal third of the fore wing is clear, the middle third dusky, with a clear transverse band, separating it from the distal third, which is dusky, with two large wedge-shaped clear spots entering it, one from the anterior and the other from the posterior border of the wing; the marginal vein is very dark brown, the remaining veins being lighter and more indistinct. General color ochre yellow; eyes brownish, ocelli carmine; antennal scape yellowish, joints 2, 3, 4, and 5 brown above, yellowish beneath, joints 6, 7, and 8 snow white, club black; metanotum brownish, and the first two joints of the abdomen with brown lateral spots; all tarsi dark at tips.

Male (Fig. 7).—Length, 0.85mm; expanse of wings, 2.2mm; greatest width of fore wing, 0.4mm. Antennal scape very short, very slightly widened below; pedicel much shorter than succeeding joint, as broad as long; flagellum cylindrical, joints nearly equal in length; club attenuate at tip, one and one-half times as long as the preceding joint; joints 5, 6, and 7 show a slight tendency to contraction in the middle; all flagellar joints furnished with forward-curved hairs about half as long as the average joint. Wings clear; marginal vein very short. Head and mesoscutum lustrous, very finely punctured, mesoscutellum more coarsely punctured. General color shining metallic green; antennal scape light yellow, flagellum dusky; mesoscutellum with a bronze or copper tinge; wing veins dark brown; all legs light yellow, nearly white; tarsi dark at tips.

Described from 4 ♀, 2 ♂ specimens.

Parasitic upon *Lecanium hesperidum* upon orange. Los Angeles, Cal. (Professor Comstock.)

The pupa of this parasite is also yellowish, and hence the infested lice do not indicate its presence as they do with *Coccophagus lecanii* and *Comys bicolor*, which are also parastic upon this species, by turning black.

25. (2) ENCYRTUS INQUISITOR new species. (Plate XXIV, Fig. 1.)

Female.—Length, 1.5mm; expanse of wings, 3mm; greatest width of fore wing, 0.48mm. Antennal scape subcylindrical, slightly widened towards tip; pedicel twice as long as thick; succeeding joints thicker than long, increasing in thickness and very slightly in length from joints 3 to 8; club long ovate, rounded at tip, slightly compressed, longer than the six preceding joints together. Marginal vein almost wanting; postmarginal long, but a trifle shorter than the stigmal, which is long and slender; at the juncture of the stigmal and marginal is a short hyaline interruption of the brown vein; the proximal third of the fore wing is clear, the remainder being cloudy; hind wings clear. Head black with bluish metallic reflections, antennae dark brown, eyes black, and ocelli carmine; head and face rather delicately punctured; mesoscutum very dark with coppery reflections, with a coarser puncturing than the head and also delicately shaggreened; mesoscutellum black with purplish reflections, nearly smooth; abdomen smooth and shining, black with purplish reflections; all coxae, femora, and tibiae dark brown; tarsi honey yellow, except last joint, which is dark brown. Ovipositor concealed.

Described from one ♀; male unknown.

Parastic upon *Dactylopius destructor*, on orange. Jacksonville, Fla.

Subfamily PIRENINAE.

Antennae inserted near the mouth; 10-jointed. Parapsides well marked. Tarsi 5-jointed. Middle tibial spur small. Abdomen sessile often compressed with the male.

TOMOCERA new genus.

Tarsi 5-jointed; middle tibiae without a strong apical spur; antennae inserted immediately above the mouth, 10-jointed ♀, 9-jointed ♂; joints of the funicle in the male compressed, and each with a strong prominence above and many long hairs; antennae clavate with the female; head very wide, acutely margined behind; eyes wide apart; ocelli forming a very obtuse-angled triangle; maxillary palpi 2-jointed; mandibles 3-dentate; labial palpi 2-jointed; parapsides of mesoscutum distinctly separated; scapulae quite widely separated from each other; abdomen ovate, slightly pedunculate; marginal vein short, not as long as stigmal; postmarginal very short, longer in ♂ than in ♀.*

26. (1) TOMOCERA CALIFORNICA new species. (Plate XXIV, Figs. 3 and 4.)

Female (Fig. 4).—Average length of body, 2.1mm; average wing expanse, 3.5mm; greatest width of fore wing, 0.65mm. Head with a delicate sculpture; all of the thorax except the scapulae with fine longitudinal punctures above; metascutum and postscutellum with a number of coarse indentations; many stout bristles sparsely scattered over dorsum of thorax. Abdomen subovate, somewhat flattened dorso-ventrally, smooth and shining; first segment very large, but the other five are plainly distinguishable. On each side of the peduncle on the anterior part of the first abdominal segment is a strong tuft of snow-white hairs. Wing veins strong, dark, bristly, the stigmal making a very small angle with the post marginal. Color: head, face, scape of antennae, and the underside of all legs light mahogany brown; thorax black with a strong metallic luster on prothorax, tip of scutellum, and scapulae; abdomen bluish black with a slight brownish patch beneath at base; flagellum of antennae blackish, with short dark hairs; border of the eyes at the top of the head bluish; front and middle coxae light brown, hind coxae shining blue black above, brownish below and at tip; all femora blackish above; middle and hind tibiae blackish above; front tibiae brownish; front tarsi yellowish, last joint black; middle tarsi whitish; hind tarsi with first and fifth joints blackish, others yellowish. The center of the fore wing is occupied by a large dusky circular patch, the inner edge of which is darker than the rest.

Male (Fig. 3).—Length, 1.5mm. General color deep metallic blue black; antennae with the scape yellow brown, the remaining joints darker; all legs light yellow brown except hind tibiae which are blackish. Wings perfectly clear.

Described from 25 ♀, 3 ♂ specimens.

Parasitic upon *Lecanium oleae* (the "black scale"), Los Angeles, Cal.

This is one of the most interesting parasites, both structurally and economically, which we have discussed in this paper. It lives upon the destructive "black scale" of California, and so abundant is it in certain regions, that Professor Comstock states that, upon more than one tree, at least 75 per cent. of the scales appeared to be parasited. In no locality was the black scale found without this attendant destroyer.

The female parasite pierces the body of the female bark-louse and deposits probably but a single egg. At all events but a single parasitic larva has ever been found under a single scale. The larva of the parasite feeds upon the eggs and the young of the *Lecanium*, and also later upon the mother herself. When full grown it is about 4mm (.15 inch),

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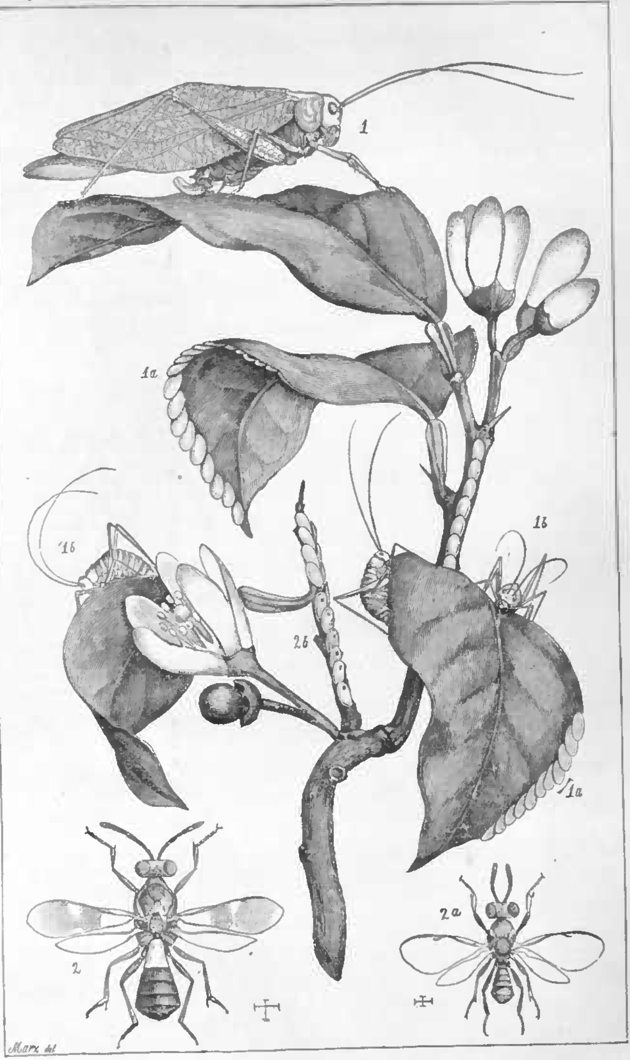
* This genus seems to have many points of affinity with the Micogastroide genus *Chatomus* of Dalman; but the character "antennae inserted immediately above the mouth" places it beyond doubt with the *Pireninae*. In this tribe it is separated from *Macroglenes* Westw. and *Calypso* Hal. (*Euryophrye* Först), by its 2-jointed maxillary palpi; from *Henicetrus* Thoms. by its short marginal vein, and from *Pirene* Hal. by the shape of its abdomen and by the male antennae.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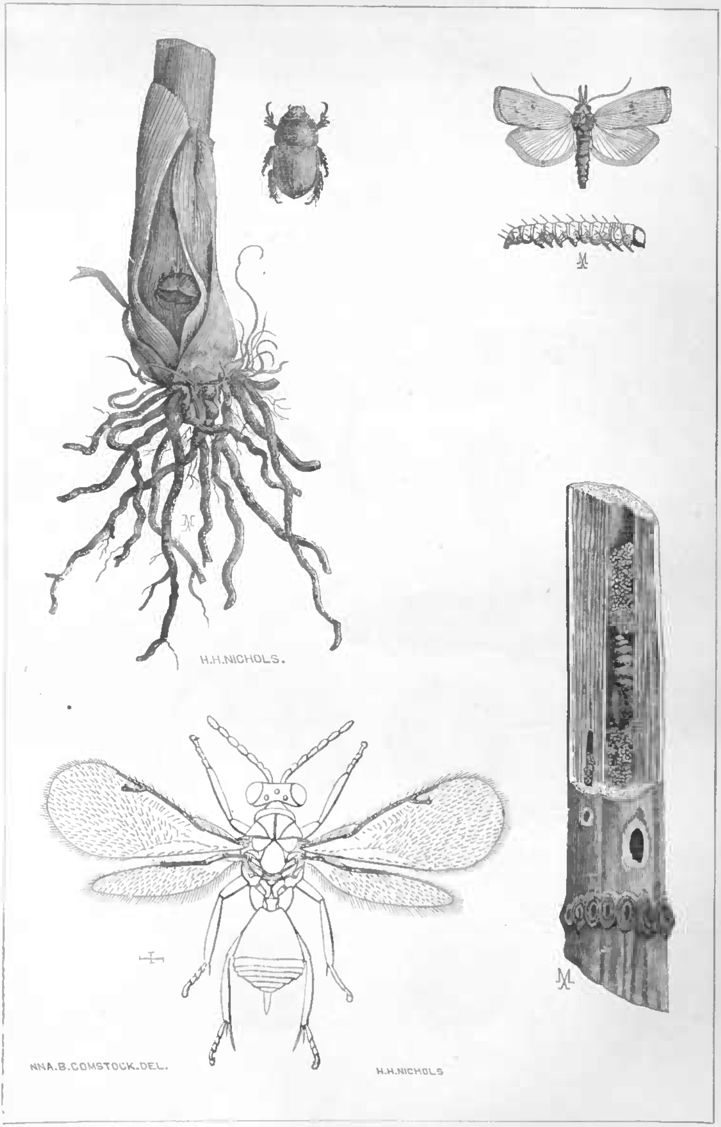
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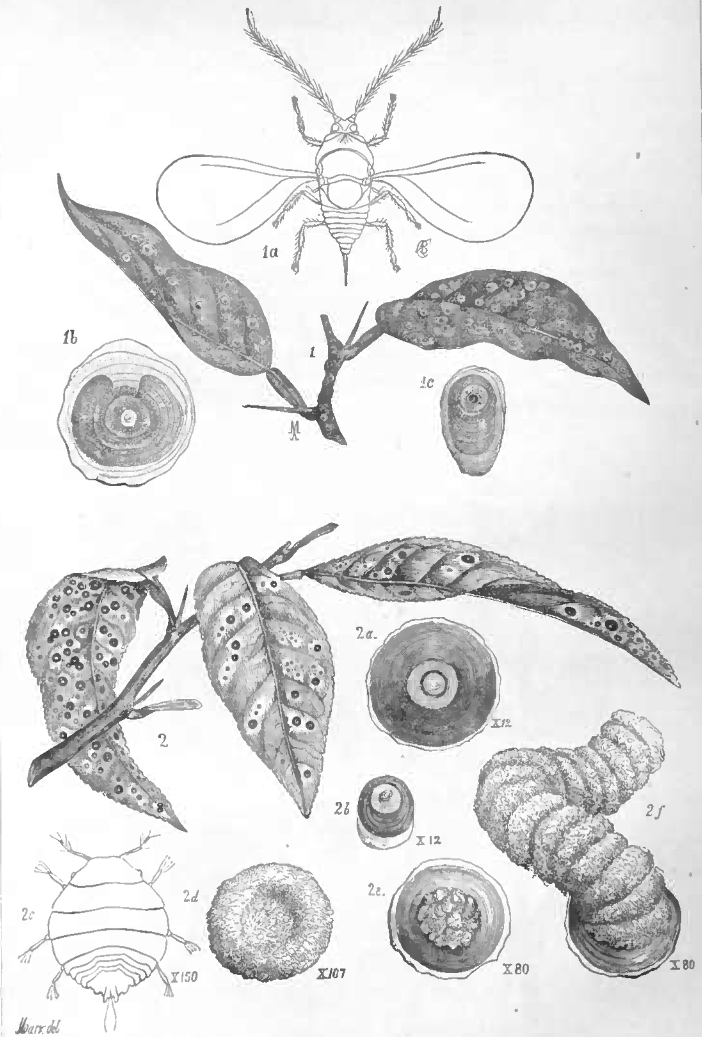
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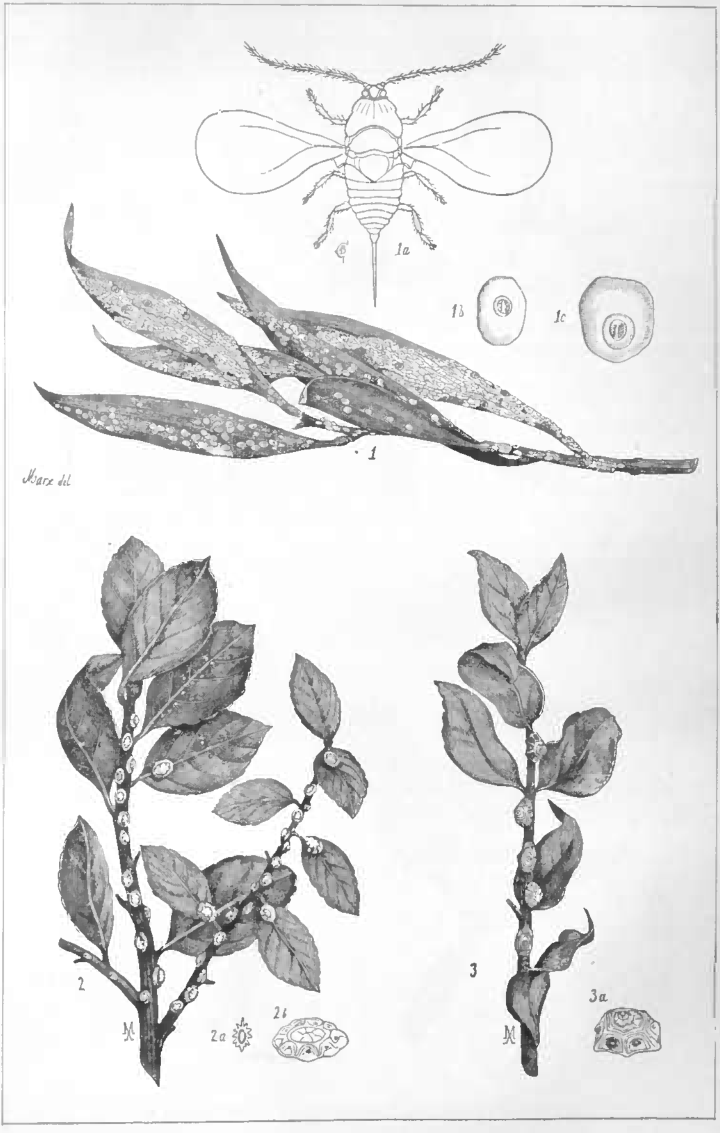
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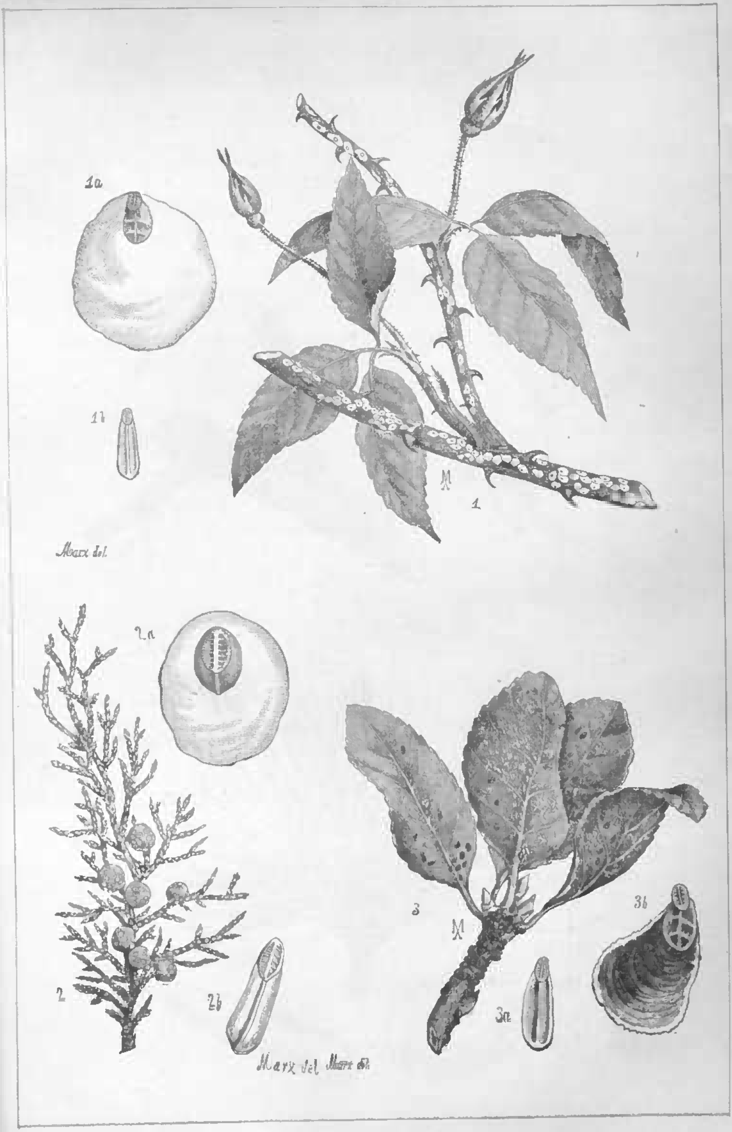
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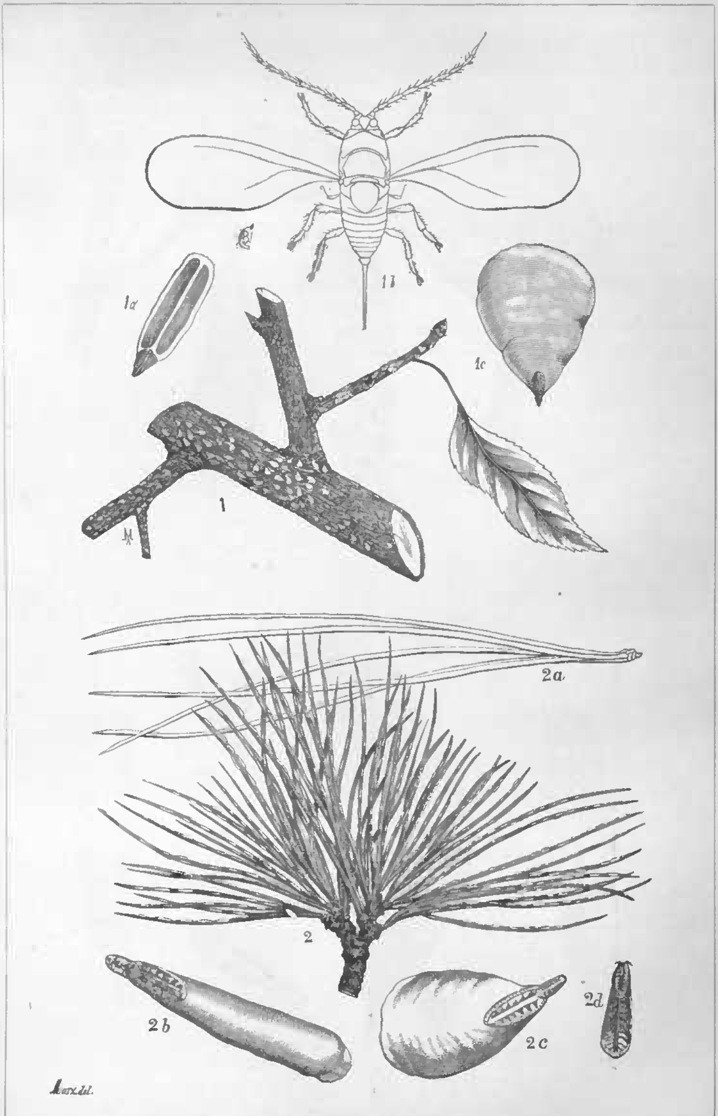
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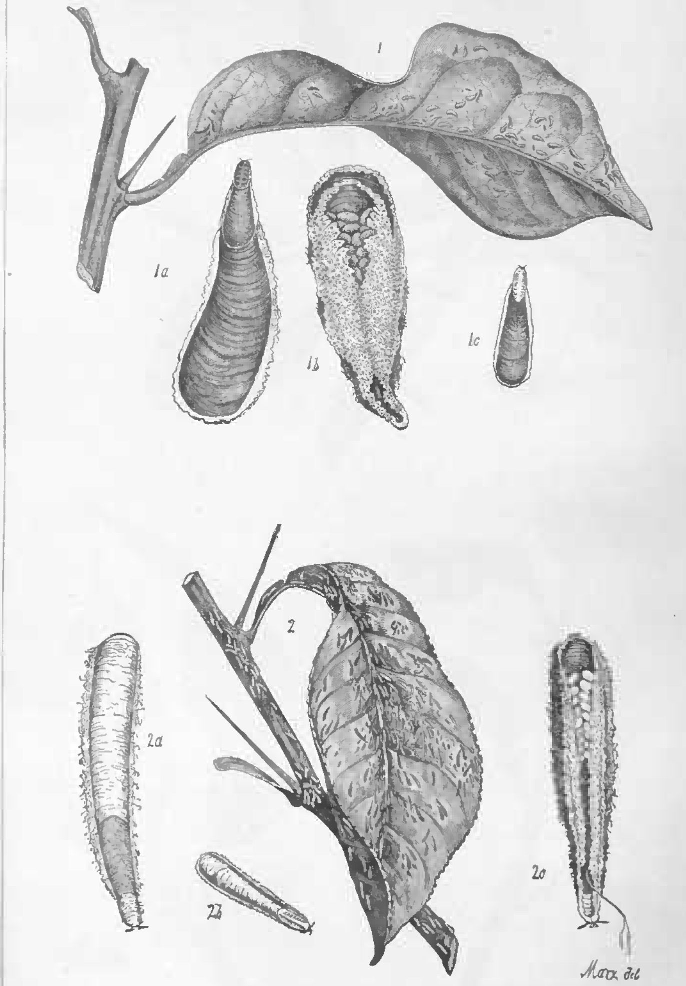
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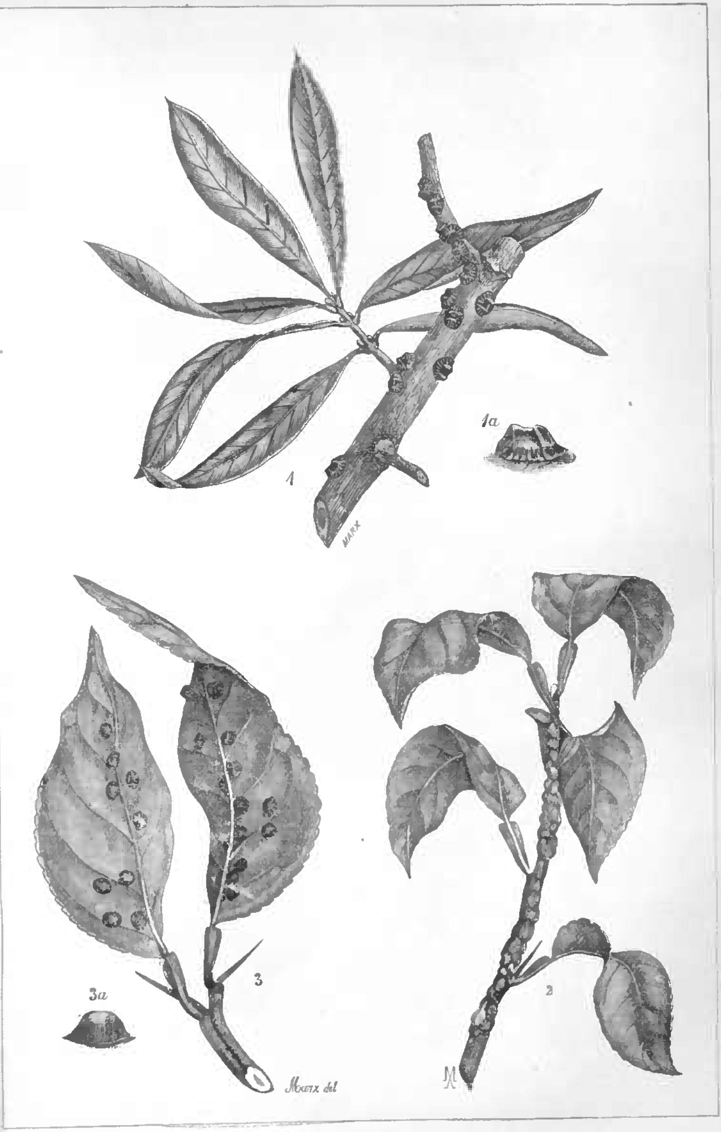
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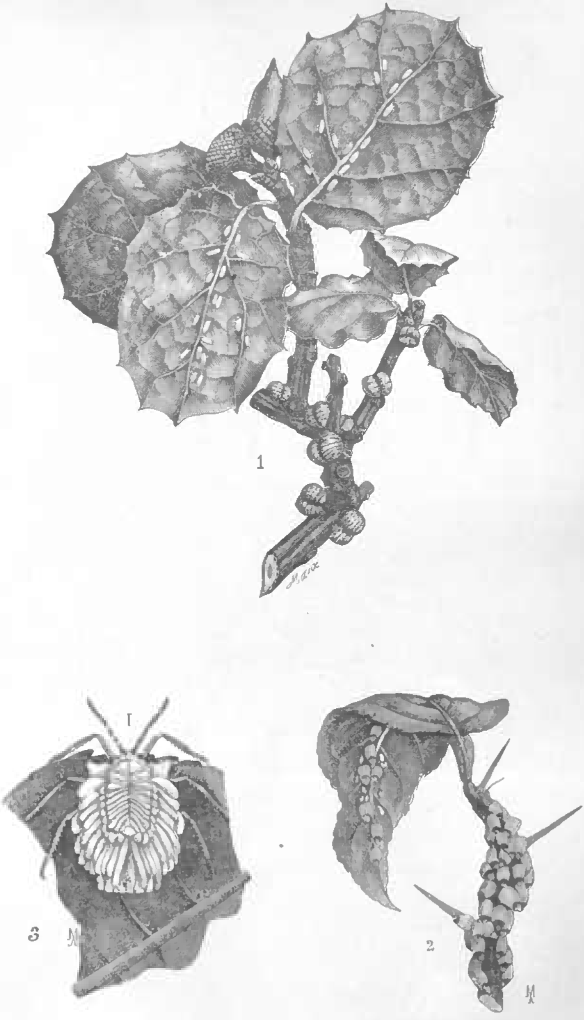
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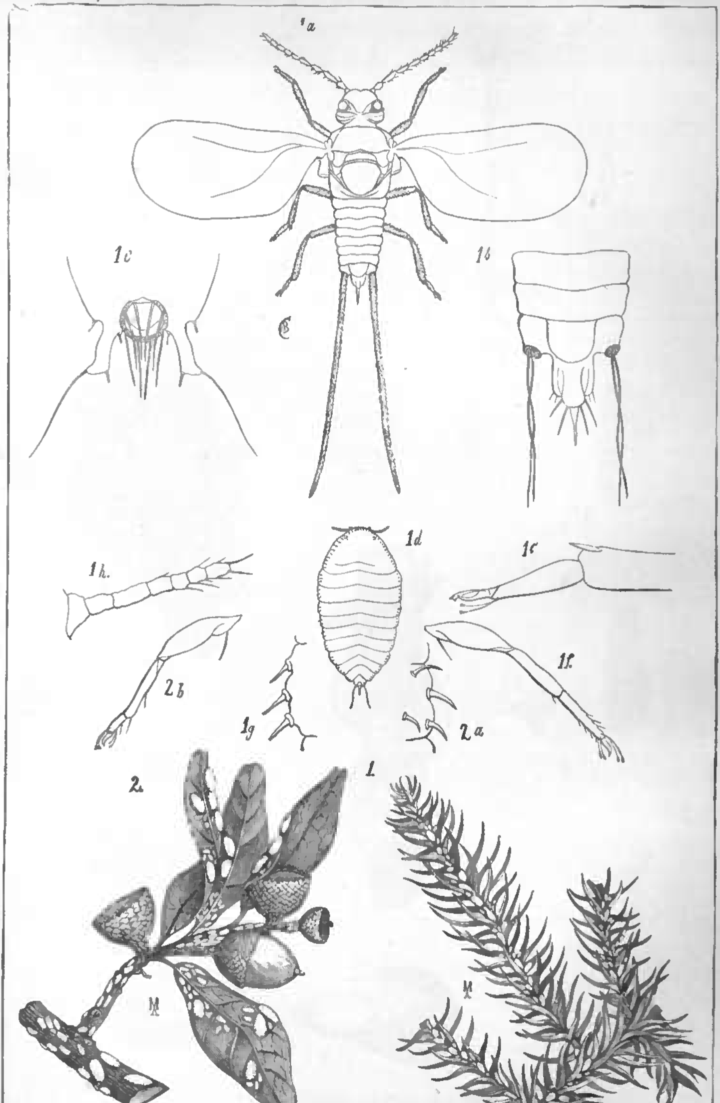
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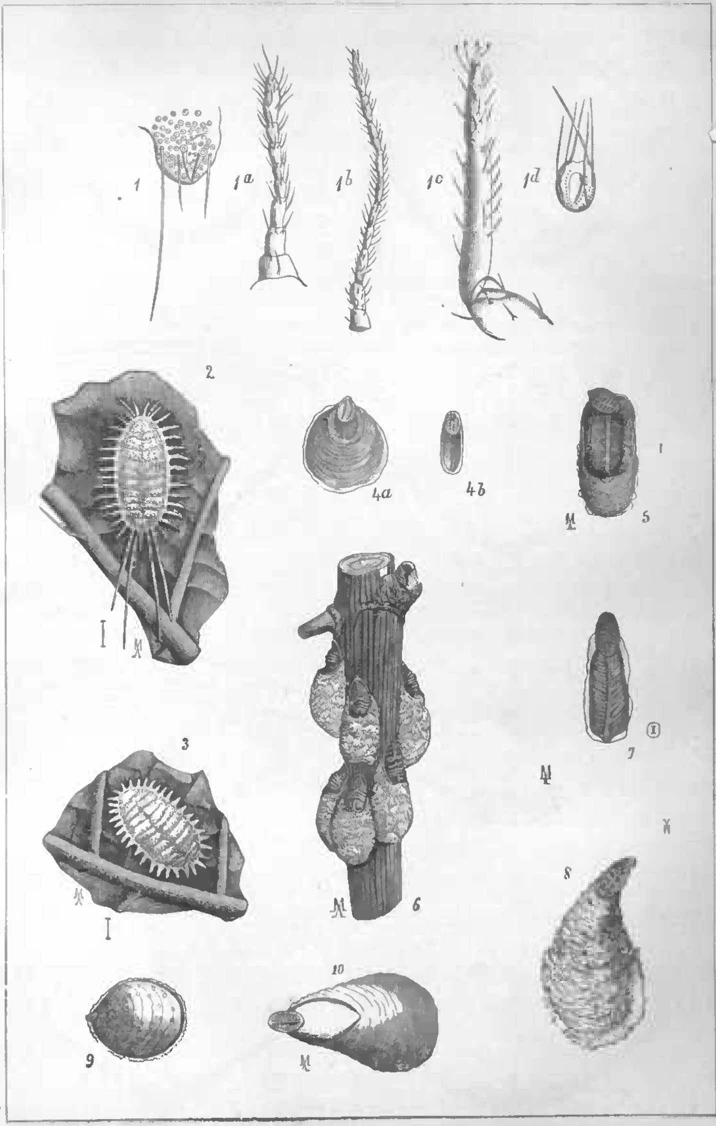
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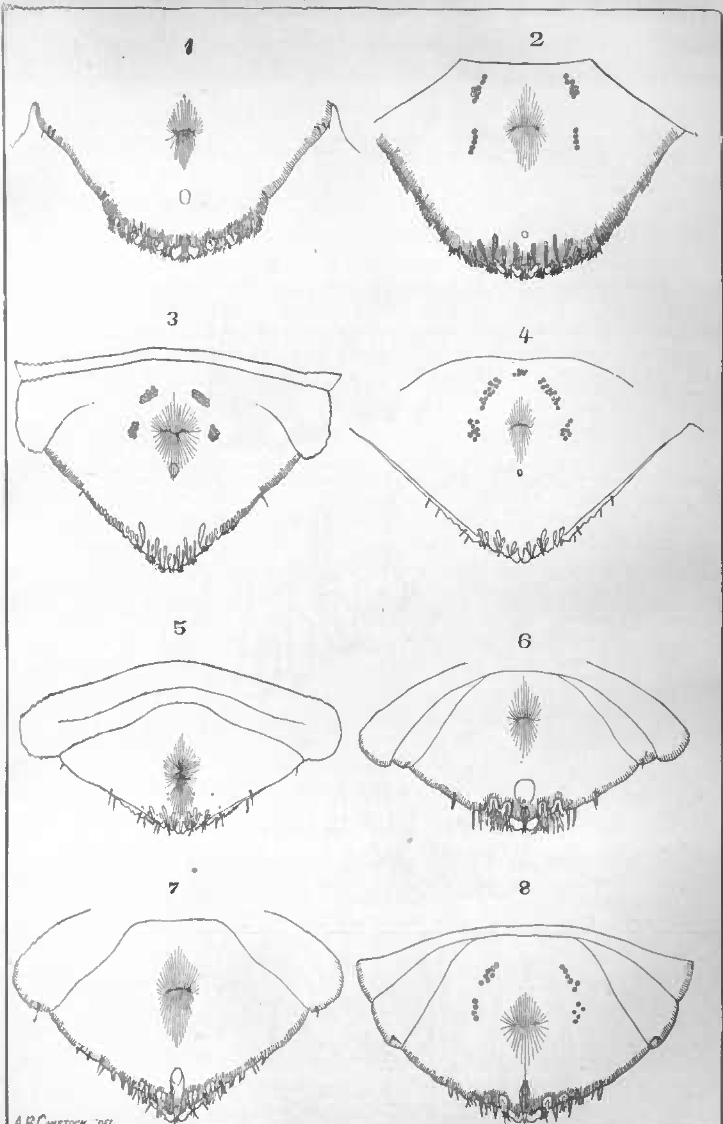
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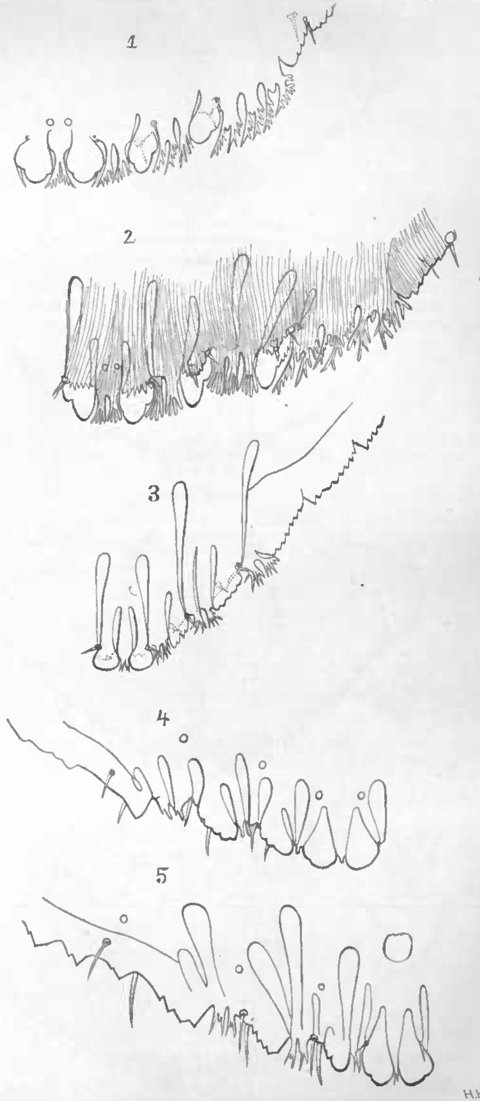
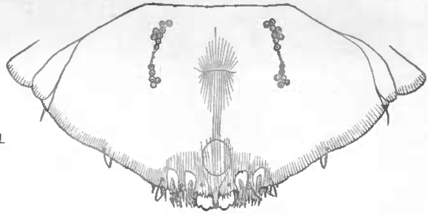


ANNA B. COMSTOCK, DEL.

H.H. NICHOLS



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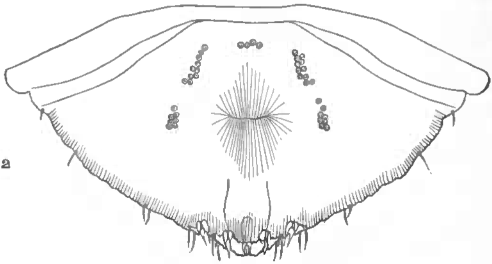

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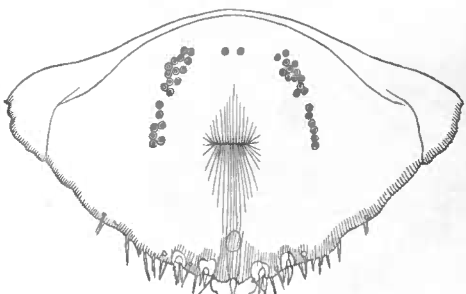

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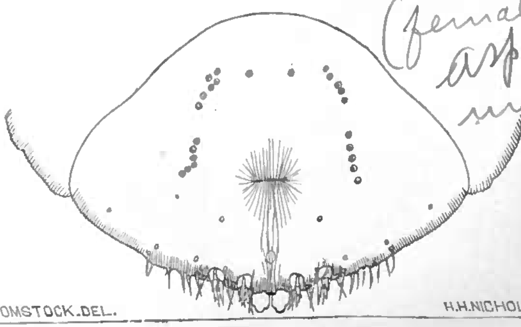

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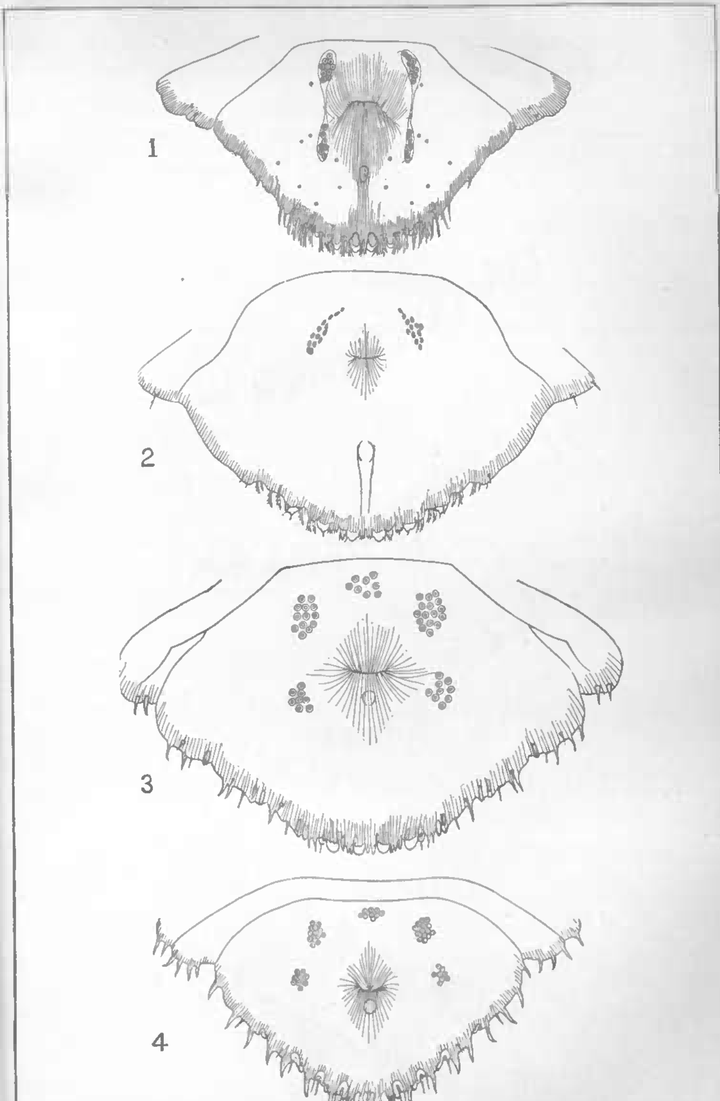
ANNA.B.COMSTOCK.DEL. H.H.NICHOLS.ENG.

PLATE XV.



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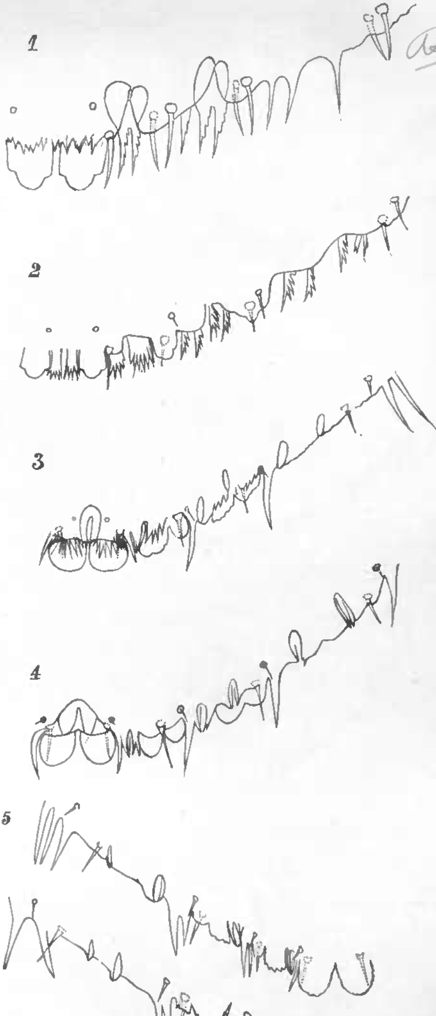
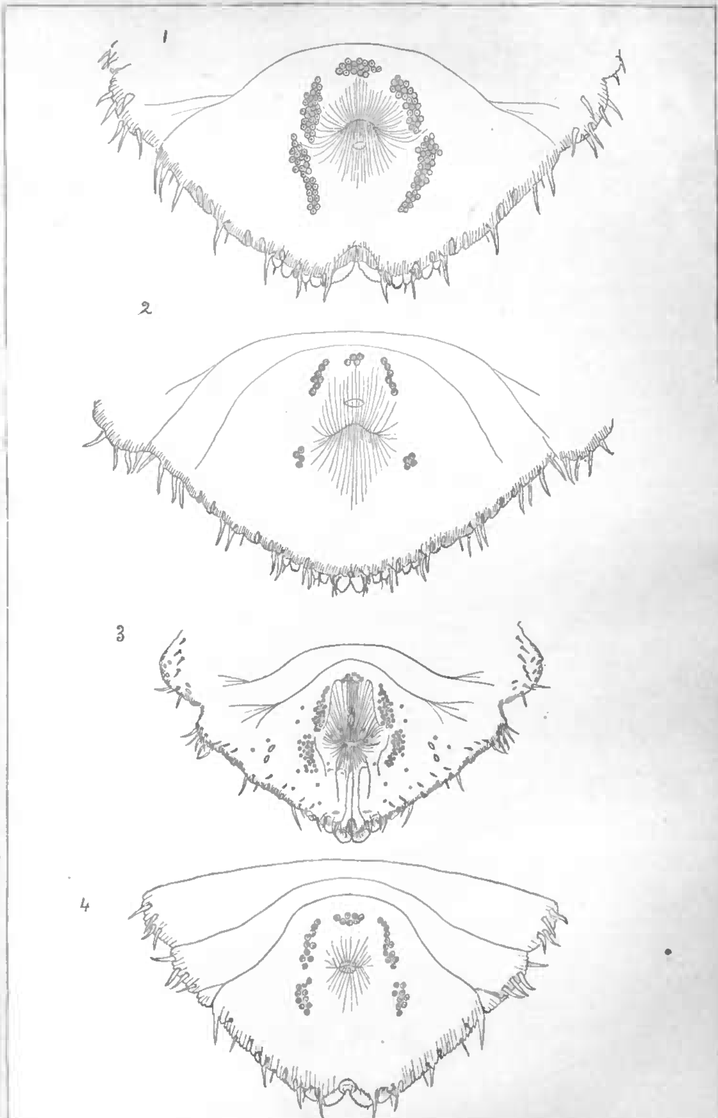


Asp. uvae

ANNA B. COMSTOCK, Del.

D. H. NICHOLS, Sc.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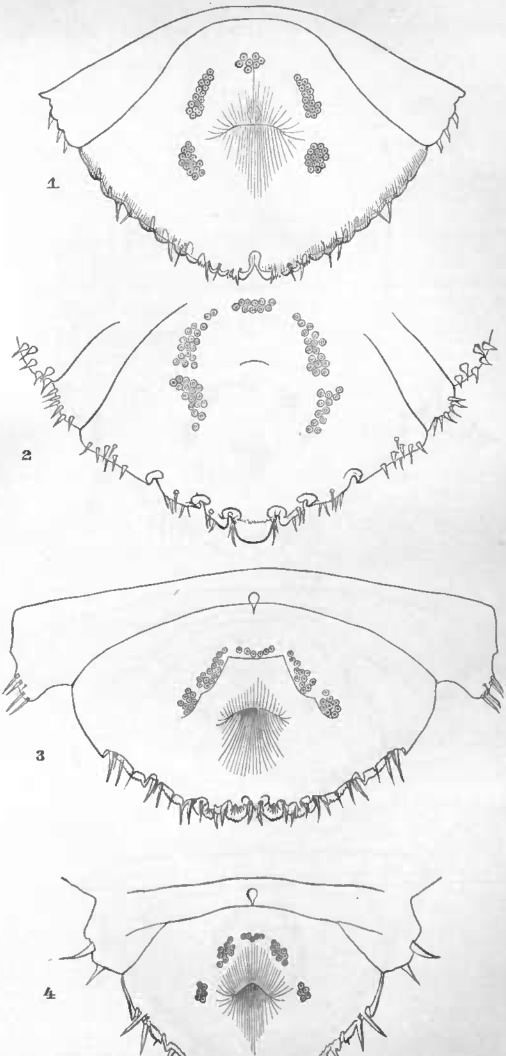

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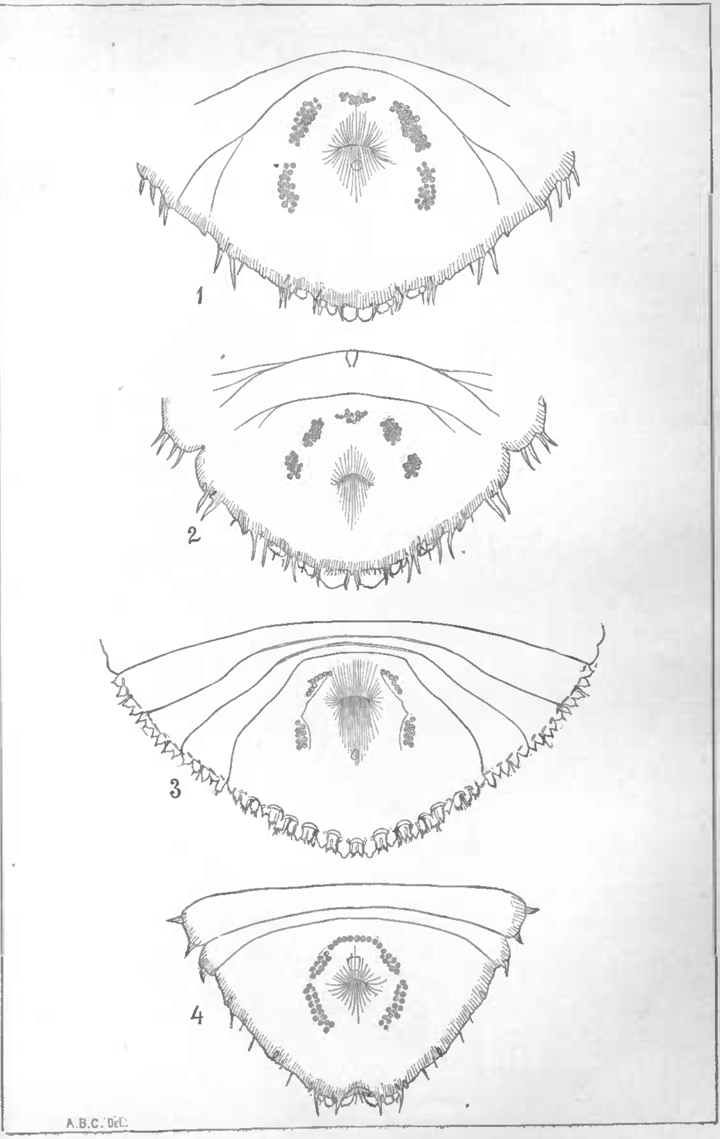
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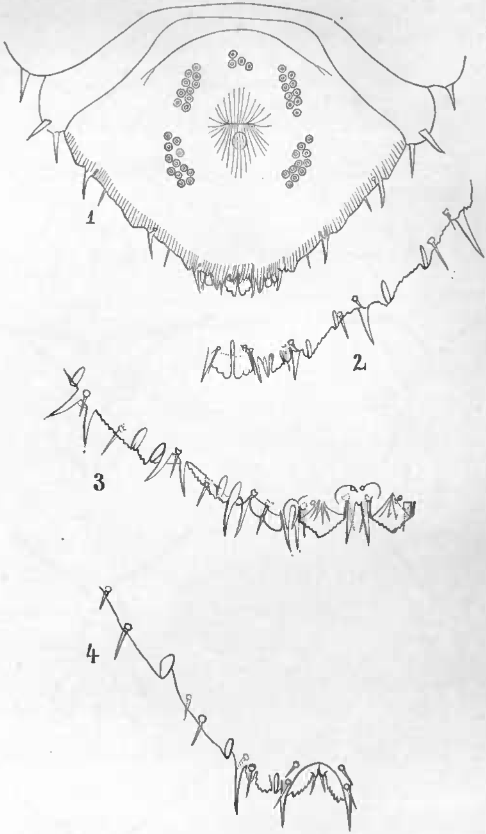

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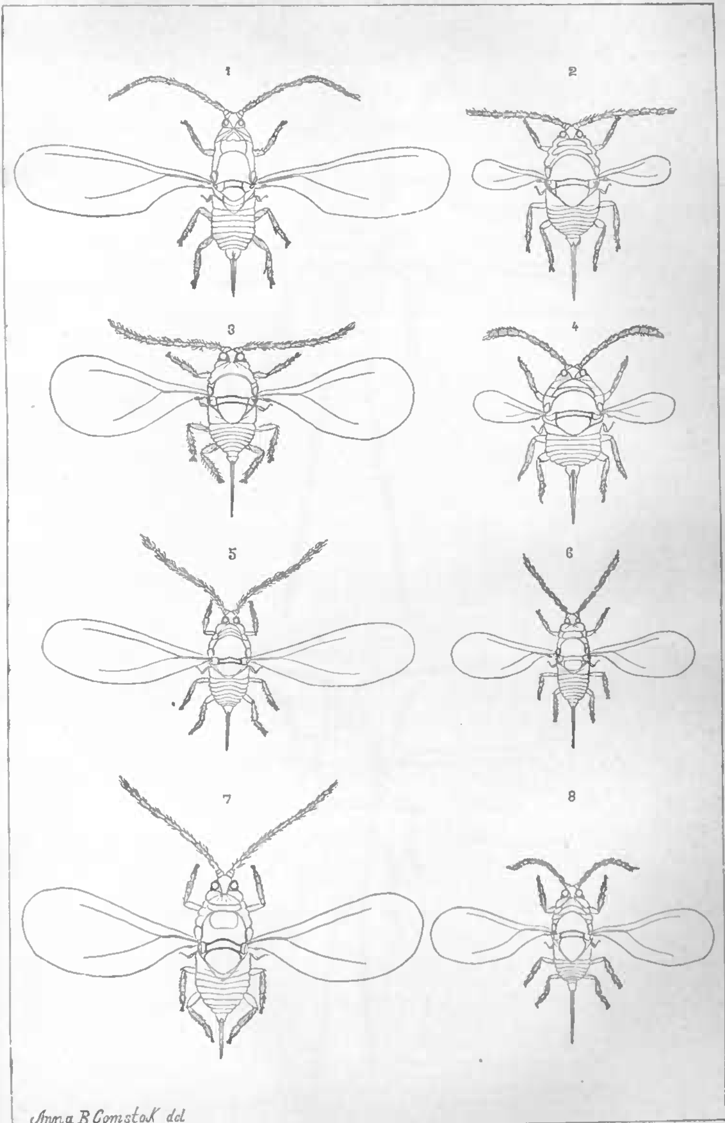
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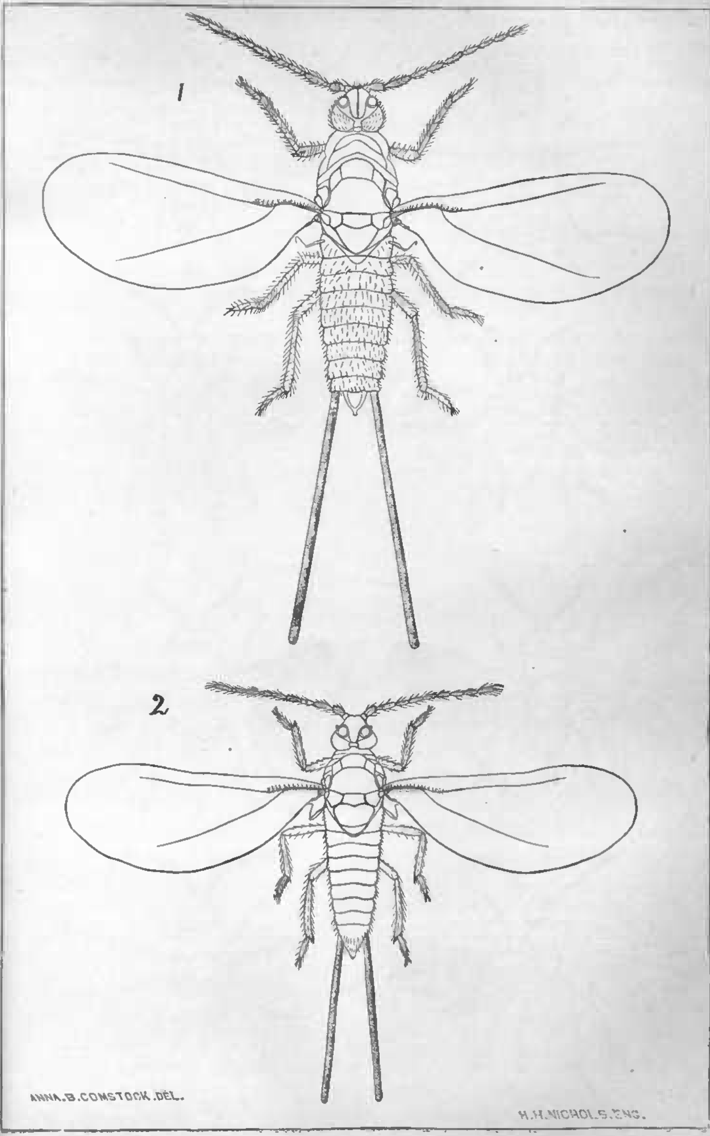

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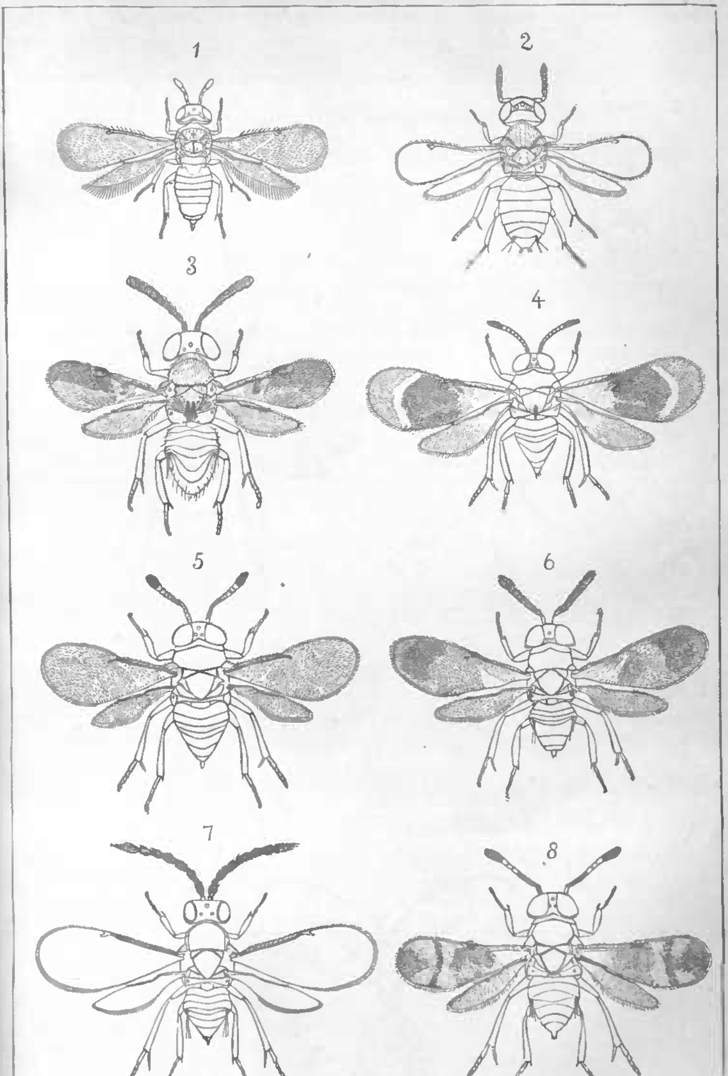
H.H.NICHOLS.ENG.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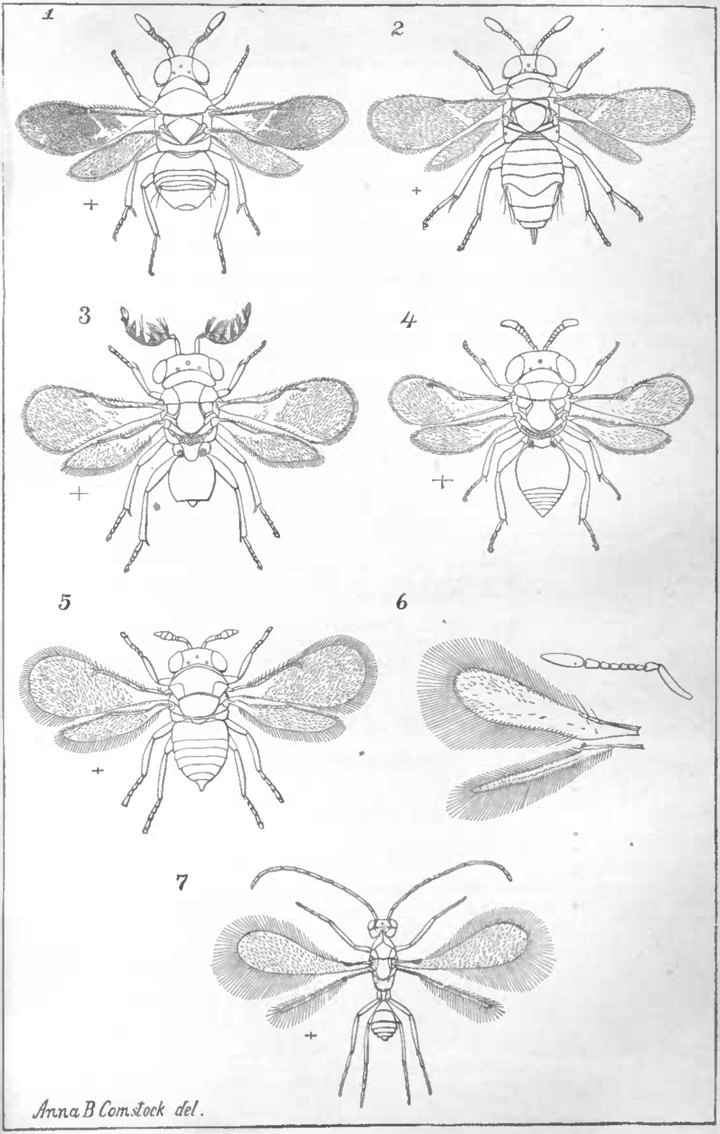
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Anna B Comstock del.

long, broad, spindle shaped, somewhat more pointed at the anterior than at the posterior end of the body. Its color is clear white, the contents of the alimentary canal, however, often showing through and giving it a blackish tinge.

This larva transforms to a whitish pupa which soon turns black. The adult parasite makes its exit through a round hole which it cuts in the back of the scale.

Subfamily TETRASTICHINAE.

Tarsi 4-jointed; sub-marginal vein broken before it reaches the costa; marginal vein not reaching beyond middle of wing.

Genus GYROLASIA FörST. (*Pterothrix* Westw.).

Tarsi 4-jointed; sub-marginal vein broken before reaching the costa; marginal vein reaching only to middle of wing; scutellum smooth, wings with long cilia; antennae 7-jointed with the ♂ with long hairs, with the ♀ 6-jointed (?).

27. (1) GYROLASIA FLAVIMEDIA new species. (Plate XXIV, Fig. 5.)

Male.—Length, 0.7mm; expanse of wings, 1.9mm; greatest width of fore-wing, 0.32mm. Antennae short and sparsely covered with stout hairs; scape rather slender; pedicel broader than scape, twice as long as broad; funicle 2-jointed, joint 1 narrower than pedicel and very short, joint 2 somewhat broader and longer than 1; club longer than pedicel and funicle together, rounded at base, pointed at tip, plainly 3-jointed, large and conspicuous. General color deep black with slight metallic reflections on dorsum of thorax; second and last abdominal segments bright orange color, but when the abdomen is bent upwards the color of the second segment is nearly if not quite hidden; scape of the antennae black, remaining joints yellowish brown; tarsi yellowish, last joint black; all legs black; underside of abdomen yellowish, as are also the mouth parts, and a patch of the prosternum into which the front coxae are inserted; wing veins black and very distinct; fore wings with a large dusky patch below the submarginal vein.

Described from many ♂ specimens; ♀ unknown.

Parasitic upon *Aleurodes* sp., on *Iris*. Collected by Professor Comstock at Los Angeles, Cal., and also from *Aleurodes* upon Fuchsia (possibly the same species). Collected by Alex. Craw, Los Angeles.

NOTE.—A species of the true genus *Tetrastichus* was bred from *Ceroplastes Floridensis*, but the material is too poor for description.

Subfamily ENTEDONINAE.

Tarsi 4-jointed; submarginal vein broken before it reaches the costa; marginal vein reaching beyond the middle of the wing.

Genus ASTICHUS Förster.

Antennae 9 or 10 jointed; incised and with whorls of hair in the ♂, and ringed with white in the ♀; submarginal vein slender. The scutellum is smooth and without a central furrow.

28. (1) ASTICHUS MINUTUS new species.

Male.—Length, 1mm; wing expanse, 2mm; greatest width of fore wing, 0.4mm. Antennae 10-jointed, each joint of the funicle with a whorl of long stiff hairs at base, those of the first funicle joint being longest, those of the succeeding joints decreasing gradually in length; joints deeply incised, color shining black; antennae light brown; all femora black, light at tips; tibiae and tarsi yellowish. Whole surface of thorax smooth and not appreciably punctured; head slightly punctured.

Described from 1 ♂ specimen; ♀ unknown.

Parasitic upon *Lecanium* sp., on peach (District of Columbia).

NOTE.—Owing to the confusion at present reigning among the genera of *Entedoninae* we hesitated a long while before describing this species, but at last deemed it necessary to give it a place. Its reference to *Astichus* is only provisional.

Family PROCTOTRUPIDAE.

The family Proctotrupidae is so closely related to Chalcididae that the dividing line has always been a prolific source of dispute among writers on Hymenoptera. We repeat the characters given before.

♂. Antennae elbowed or not elbowed, with no ring joint between pedicel and funicle; seldom with one small ring joint, but then not elbowed.
♀. The ovipositor always issues from the tip of the abdomen.

The two subfamilies of which we have representatives may be separated as follows:

A. Abdomen bordered around the sides; antennae inserted near the border of the mouth; wings with a marginal and sometimes, also, with a stigmal vein; the unwinged genera without ocelli .... SCELIONINAE.
B. Abdomen not bordered; antennae inserted far above the borders of the mouth; hind wings without a trace of a middle vein, very small, almost linear. MYMARINAE.

Subfamily SCELIONINAE.

Genus TELENOMUS Haliday.

Antennal club jointed; submarginal vein not shortened, reaching the costa; marginal vein very short, usually shorter than the stigmal vein; second abdominal segment larger than the others.*

29. A single species of this genus was bred from a large *Kermes* on oak, the same species of *Kermes* which is parasited by the larva of *Hamadryas bassetela*, but owing to defective mounting the specimens are so poor that I hesitate to describe the species.

Subfamily MYMARINAE.

Genus ANAPHES Haliday.

Tarsi 4-jointed; abdomen sessile; antennae with the male 12-jointed, with the female 9-jointed; marginal vein rather long and somewhat thickened on the end.

30. (1) ANAPHES GRACILIS new species. (Plate XXIV, Fig. 6.)

Female.—Length, 0.7^{mm}; wing expanse, 1.4^{mm}; greatest width of fore wing, 0.15^{mm}; of hind wing, 0.13^{mm}. Antennae as long as head and thorax together; scape stout; pedicel large; joint 3 slender; joints 4, 5, 6, 7, and 8, gradually increase in length and thickness; club large and as long as the four preceding joints together, somewhat pointed at tip. Number of marginal cilia to the fore wings about 70. General color dark brown, nearly black; antennae rather light brown, club darker; all legs dark brown, lighter at joints; tarsi lighter; base of abdomen yellowish; wing veins dusky.

Described from 1 ♀ specimen; ♂ unknown.

Parasitic upon *Mytilaspis pomorum* Bouché. District of Columbia.

* These are the old generic characters given by Förster in his Hym. Stud. II, 100. I have not been able to consult Thomsen's Skand. Proctruper, and Mayr in his paper upon this genus does not give what he considers to be the characters.

Genus Cosmocoma Först.

Tarsi 4-jointed; antennal club not jointed; abdomen petiolated; fore wings widening gradually; the marginal vein appearing as a dot.

31. (1) Cosmocoma elegans new species. (Plate XXIV, Fig. 7.)

Male.—Length, 0.9mm; wing expanse, 2.1mm; greatest width of fore wing, 0.18mm Antennae 13-jointed, considerably longer than the whole body; scape very short, broadened; pedicel bulbous, much broader than the succeeding joint. Color shining black; scape and pedicel of the antennae brown, the rest black; all tarsi entirely light honey-yellow except the last joint, which is nearly black; wing veins nearly black.

Described from 2 ♀ specimens; ♀ unknown.

Parasitic upon *Kermes* sp. Santa Rosa, Cal.

The two specimens in the collection were bred from the same individual scale.

Note.—Two or three additional species of *Mymarinae* have been bred from species of *Mytilaspis*, but I am unable to place them in any known genus, and the material is too scanty to warrant the founding of a new genus for them.

IN CONCLUSION.

Fitch in his Third N. Y. Report, p. 109, speaks of the currant bark-louse (*Lecanium ribis* Fitch) as being "often perforated with one, two, or three holes from which have issued minute, brilliant green four-winged flies, which in their larva state have fed upon and consumed the minute eggs which originally existed under the scales."

No further description is given of this parasite, and we are at a loss as to where to place it. In a like manner he speaks (*ibid.*, p. 145) of a chalcid parasite upon his butternut bark-louse (*Aspidiotus juglandis*).

In "Orange insects," Jacksonville, Fla., 1880, Mr. W. H. Ashmead describes one new genus, and four new species of chalcids (?), three of which are parasitic upon coccids and hence should be mentioned here. The first, *Aphelinus aspidioticola* Ashmead, is parasitic upon the long orange scale (*Mytilaspis Gloveri* Pack.), but is, as we have stated before, no *Aphelinus*, as the figures of the antennae and fore wing plainly show. It is evidently a Proctotrupid of the subfamily *Mymarinae*, but we should hesitate to make a generic determination without seeing specimens.

The new genus (*Signiphora*, founded for *S. flavopalliatus* Ashmead), we are not prepared to discuss at the present, but would simply state that specimens of an insect corresponding very exactly with his description have been bred from the same scale (*Mytilaspis citricola* Pack.), and that the "anomalous 5-lobed appendage" which Mr. Ashmead locates upon the hind tibiae of *Signiphora* is present upon the middle tibae, and is homologous with the middle tibal spine of the *Encyrtinae* and *Aphelininae*. The genus is also to be placed with the *Mymarinae*. Concerning the third species, *Trichogramma flavus* Ashmead, which is said to probably prey upon *Lecanium hesperidum*, we have only to say that Mr. Ashmead figures the tarsi with five joints and distinctly says, "tarsi 5-jointed," while in reality the main characteristic of the subfamily *Trichogramminae*, of which this is the typical genus, is 3-jointed tarsi.

As to the species called by him *Stenomesius aphidicola*, it plainly cannot be placed in this genus from its 5-jointed tarsi (in *Stenomesius* they are 4-jointed) and from its sessile abdomen.

EXPLANATION OF PLATES.

PLATE I. (Original.)

FIG. 1.—*Microcentrum retinervis* Scudder. 1, adult; 1 *a*, eggs; 1 *b*, young, on orange.

FIG. 2.—*Eupelmus mirabilis* (Walsh). 2, adult female; 2 *a*, adult male; 2 *b*, eggs of *M. retinervis* from which *Eupelmus mirabilis* have emerged.

PLATE II. (Original.)

FIG. 1.—*Euplectrus Comstockii* Howard.

FIG. 2.—*Diatraea sacchari* Fabr.

FIG. 3.—*Ligyrus rugiceps* Lec.

PLATE III. (Original.)

FIG. 1.—*Aspidiotus aurantii* Maskell. 1, scales on leaves of orange, natural size; 1 *a*, adult male, much enlarged; 1 *b*, scales of female, enlarged; 1 *c*, scale of male, enlarged.

FIG. 2.—*Aspidiotus ficus* (Riley Ms.). 2, scales on leaves of orange, natural size; 2 *a*, scale of female, enlarged; 2 *b*, scale of male, enlarged; 2 *c*, young larva; 2 *d*, 2 *e*, and 2 *f*, different stages in the formation of the scale.

PLATE IV. (Original.)

FIG. 1.—*Aspidiotus nerii* Bouché. 1, scales on leaves of acacia, natural size; 1 *a*, adult male, enlarged; 1 *b*, scale of male, enlarged; 1 *c*, scale of female, enlarged.

FIG. 2.—*Ceroplastes Floridensis* new species. 2, adult and young females on Ilex, natural size; 2 *a*, young female, enlarged; 2 *b*, adult female, enlarged.

FIG. 3.—*Ceroplastes cirripediformis*, new species. 3, adult females, natural size; 3 *a*, female, enlarged.

PLATE V. (Original.)

FIG. 1.—*Diaspis rosae* (Sand.). 1, scales on rose, natural size; 1 *a*, scale of female, enlarged; 1 *b*, scale of male, enlarged.

FIG. 2.—*Diaspis Carueli* Targ.-Tozz. 2, scales on juniper, natural size; 2 *a*, scale of female, enlarged; 2 *b*, scale of male, enlarged.

FIG. 3.—*Chionaspis euonymi* new species. 3, scales on euonymus, natural size; 3 *a*, scale of male, enlarged; 3 *b*, scale of female, enlarged.

PLATE VI. (Original.)

FIG. 1.—*Chionaspis furfurus* (Fitch). 1, scales on pear, natural size; 1 *a*, scale of male, enlarged; 1 *b*, adult male, enlarged; 1 *c*, scale of female, enlarged.

FIG. 2.—*Chionaspis pinifoliae* (Fitch). 2, scales on *Pinus strobus*, natural size, leaves stunted; 2 *a*, leaves of *P. strobus* not stunted by coccids; 2 *b*, scale of female, usual form, enlarged; 2 *c*, scale of female, wide form, enlarged; 2 *d*, scale of male, enlarged.

PLATE VII. (Original.)

FIG. 1.—*Mytilaspis citricola* (Pack.). 1, scales on orange, natural size; 1 *a*, scale of female, dorsal view, enlarged; 1 *b*, scale of female with ventral scale and eggs, enlarged; 1 *c*, scale of male, enlarged.

FIG. 2.—*Mytilaspis Gloverii* (Pack.). 2, scales on orange, natural size; 2 *a*, scale of female, dorsal view, enlarged; 2 *b*, scale of male, enlarged; 2 *c*, scale of female with ventral scale and eggs, enlarged.

PLATE VIII. (Original.)

FIG. 1.—*Lecanium oleae* Bernard. 1, adult females on olive, natural size; 1 *a*, female, enlarged.

FIG. 3.—*Lecanium hesperidum* Linn. Adult females, on orange, natural size.

FIG. 3.—*Lecanium hemisphericum* Targ. 3, adult females on orange, natural size; 3 *a*, adult female, enlarged.

PLATE IX. (Original.)

FIG. 1.—*Kermes* sp., on *Quercus agrifolia*. Adult females on stem; immature males on leaves.

FIG. 2.—*Icerya purchasi* Maskell. Females, adult and young, on orange.

FIG. 3—*Orthezia* sp.

PLATE X. (Original.)

FIG. 1.—*Rhizococcus araucariae* (Maskell). 1, sacs of male and female on Norfolk Island pine, natural size; 1 *a*, adult male, enlarged; 1 *b*, caudal extremity of male with excretion removed; 1 *c*, the same of female; 1 *d*, adult female, enlarged; 1 *e*, tarsus of male, showing digitules; 1 *f*, leg of female; 1 *g*, spinnerets of female; 1 *h*, antenna of female.

FIG. 2.—*Rhizococcus quercus* new species. 2, sacs of male and female on *Quercus virens*, natural size; 2 *a*, spinnerets of female enlarged; 2 *b*, leg of female, enlarged.

PLATE XI. (Original except Fig. 1.)

FIG. 1.—*Dactylopius adonidum* Lin. (after Signoret). 1, lateral lobe of the abdominal extremity of the female; 1 *a*, antenna of the female; 1 *b*, antenna of male; 1 *c*, leg of the female; 1 *d*, anal ring with six hairs.

FIG. 2.—*Dactylopius longifilis* new species; female, enlarged.

FIG. 3.—*Dactylopius destructor* new species; female, enlarged.

FIG. 4.—*Parlatoria Pergandii* new species. 4 *a*, scale of ——, enlarged; 4 *b*, scale of ——, enlarged.

FIG. 5.—*Parlatoria zizyphi* Lucas; scale of female, enlarged.

FIG. 6.—*Pulvinaria* on grape; female, natural size.

FIG. 7.—*Fiorinia camelliae* new species; scale of female, enlarged.
FIG. 8.—*Chionaspis quercus* new species; scale of female, enlarged.
FIG. 9.—*Asterodiaspis quercicola* (Bouché); enlarged.
FIG. 10.—*Mytilaspis* [———].

PLATE XII. (Original.)

FIG. 1.—*Aspidiotus aurantii* Maskell.
FIG. 2.—*Aspidiotus ficus* (Riley Ms.).
FIG. 3.—*Aspidiotus perseae* n. sp.
FIG. 4.— *Aspidiotus obscurus* n. sp.
FIG. 5.—*Aspidiotus tenebricosus* n. sp.
FIG. 6.—*Aspidiotus rapax* n. sp.
FIG. 7.—*Aspidiotus perniciosus* n. sp.
FIG. 8.—*Aspidiotus convexus* n. sp.

PLATE XIII.

FIG. 1.—*Aspidiotus aurantii* Maskell.
FIG. 2.—*Aspidiotus ficus* (Riley Ms.).
FIG. 3.—*Aspidiotus perseae* n. sp.
FIG. 4.—*Aspidiotus obscurus* n. sp.
FIG. 5.—*Aspidiotus tenebricosus* n. sp.

PLATE XIV.

FIG. 1.—*Aspidiotus cydoniae* n. sp.
FIG. 2.—*Aspidiotus juglans-regiae* n. sp.
FIG. 3.—*Aspidiotus ancylus* Putnam.
FIG. 4.—*Aspidiotus uvae* n. sp.

PLATE XV.

FIG. 1.—*Aspidiotus nerii* Bouché.
FIG. 2.—*Aspidiotus* (?) *pini* n. sp.
FIG. 3.—*Diaspis carueli* Targ.-Tozz.
FIG. 4.—*Diaspis ostreaeformis* Curtis.

PLATE XVI.

FIG. 1.—*Aspidiotus uvae* n. sp.
FIG. 2.—*Aspidiotus* (?) *pini* n. sp.
FIG. 3.— *Chionaspis furfurus* (Fitch).
FIG. 4.—*Chionaspis pinifoliae* (Fitch).
FIG. 5.—*Chionaspis salicis* (Linn.).
FIG. 6.—*Chionaspis ortholobis* n. sp.

PLATE XVII.

FIG. 1.—*Diaspis rosae* Sandberg.
FIG. 2.—*Chionaspis euonymi* n. sp.
FIG. 3.—*Chionaspis furfurus* (Fitch).
FIG. 4.—*Chionaspis nyssae* n. sp.

PLATE XVIII.

FIG. 1.—*Chionaspis pinifoliae* (Fitch).
FIG. 2.—*Chionaspis quercus* n. sp.
FIG. 3.—*Mytilaspis citricola* (Pack.).
FIG. 4.—*Mytilaspis gloverii* (Pack.).

PLATE XIX.

FIG. 1.—*Chionaspis ortholobis* n. sp.
FIG. 2.—*Mytilaspis pomorum* Bouché.
FIG. 3.—*Parlatoria pergandii* n. sp.
Fig. 4.—*Fiorinia camelliae* n. sp.

PLATE XX.

FIG. 1.—*Mytilaspis pandanni* n. sp.
FIG. 2.—*Mytilaspis pandanni.*
FIG. 3.—*Mytilaspis citricola* (Pack.).
FIG. 4.—*Fiorinia camelliae* n. sp. (dorsal view).
FIG. 5.—*Parlatoria pergandii* n. sp.

PLATE XXI.

FIG. 1.—*Mytilaspis gloverii* (Pack.).
FIG. 2.—*Aspidiotus ancylus* Putnam.
FIG. 3.—*Aspidiotus ficus* (Riley Ms.).
FIG. 4.—*Aspidiotus ancylus* Putnam.
FIG. 5.—*Diaspis rosae* Sand.
FIG. 6.—*Diaspis carueli* Targ.-Tozz.
FIG. 7.—*Aspidiotus* (?) *pini* n. sp.
FIG. 8.—*Parlatoria pergandii* n. sp.

PLATE XXII.

FIG. 1.—*Dactylopius longifilis* n. sp.
FIG. 2.—*Dactylopius destructor* n. sp.

PLATE XXIII.

FIG. 1.—*Aphelinus mytilaspidis* Le Baron.
FIG. 2.—*Coccophagus cognatus* n. sp.
FIG. 3.—*Comys bicolor* n. sp.
FIG. 4.—*Chiloneurus albicornis* n. sp.
FIG. 5.—*Aphycus eruptor* n. sp.
FIG. 6.—*Blastothrix adjutabilis* n. sp.
FIG. 7.—*Encyrtus flavus* n. sp. ♂.
FIG. 8.—*Encyrtus flavus* n. sp. ♀.

PLATE XXIV.

FIG. 1—*Encyrtus inquisitor* n. sp.
FIG. 2.—*Rhopus coccois* (Smith).
FIG. 3.—*Tomocera californica* n. sp. ♂.
FIG. 4.—*Tomocera californica* n. sp. ♀.
FIG. 5.—*Gyrolasia flavimedia* n. sp.
FIG. 6.—*Anaphes gracilis* n. sp.
FIG. 7.—*Cosmocoma elegans* n. sp.

REPORT OF THE BOTANIST.

SIR: In continuation of our report on the native and naturalized grasses, we present figures and descriptions of twenty-five species which have more or less value in agriculture. The object of these articles is to call the attention of farmers and agriculturists to the great variety of grasses existing, and by means of minute descriptions and figures to enable them to recognize such species as may come under their observation. The system of grass culture in this country is undoubtedly capable of great improvement, not only in the adaptation of the proper species to different climates and soils, but in the advantages to be gained by a more diversified use of several species in the same fields.

To produce good results in these directions requires knowledge and intelligent observation of the characters and habits of the various kinds which may be met with in a wild state, as well as of those which have been long under cultivation. A cheap pocket lens, which may be bought for a dollar or less, will be found of value in the study of the structure of the flowers of the grasses.

In the descriptions of the grasses we have adopted the nomenclature of Mr. Bentham, in calling the lower pair of glumes in the spikelet the *outer* glumes, and all the others (which have commonly been called *lower palets*) the flowering glumes, thus counting as a *palet* only what has been commonly called the *upper palet.*

It is proper here to state that in the Report for 1879 a figure of *Aristida purpurascens* was given instead of *Aristida purpurea* (Plate XXV). The error was not observed until too late for correction in that volume, and we now present a figure of *Aristida purpurea* (Plate XXVI), which is the grass described in the volume for 1879, page 359.

PASPALUM OVATUM *Tr.*

Culms from a thick perennial rhizome, erect, 3 to 5 feet high, firm, smooth, marked by fine lines, with three or four leaves from as many dark, smooth joints.

Leaves at the base of the culm numerous, becoming withered and torn, somewhat hairy; the leaves on the culm erect, one-quarter inch or more wide, some of the lower ones a foot or more in length, upper ones shorter, gradually long pointed, smooth both sides, roughish on the margins. The sheaths are rather loose, smooth, and longer than the joints. The raceme or flowering part is usually 6 to 8 inches long, composed of from three to six spikes, which are 1 to 2 inches apart on the rather slender axis; the lower spikes are 3 inches or more in length, the upper ones gradually shorter, slightly spreading, all with a few long hairs at the base. The spikelets are closely arranged in four rows, two on each side of the narrow and mostly straight rachis, in alternate pairs. The spikelets are about 1½ lines long, ovate, pointed, crowded, and overlapping, compressed, and the margins clothed with silky hairs. The two outer or empty glumes are ovate, acute, 5-nerved, smooth, or nearly so, except on the margin, which is edged with thin white hairs. The inner or flowering glumes are cartilaginous in texture, roundish, obtuse, compressed, smooth, and shining, and, under the glass, very delicately punc-

tate. The proper palet (upper palet) is of similar texture, fits into the margin of the flowering glume, and has a thin inflexed margin, infolding the three stamens and two feathery, purple styles.

This grass has only recently been detected in this country, and seems confined to few localities. It was collected in Louisiana by Dr. Ravenel; also, later at Fortress Monroe, Va., by the writer, and more recently by Mr. S. B. Wallis, of Wallisville, Tex. It is also a South American species. Mr. Wallis says:

> This grass I consider the most valuable of all the grasses that I am acquainted with. It is perennial, and grows here all the year round, furnishing excellent green feed for stock at all seasons, except that the green blades freeze in our very coldest weather, perhaps two or three times in a winter, and then grow out again in a few days' time. It increases rapidly from seeds, and also reproduces itself from suckers, which sprout from the nodes of the culm after the first crop of seeds has ripened. I have seen these suckers remain green for six or eight weeks after the old stalks were as dead and dry as hay, and then, when the old stalk had fallen to the ground, take root and form new plants. It grows well on all kinds of dry land. The plants with roots two or three years old form stools 12 to 18 inches across, have very strong roots, and grow in the longest drouth almost as fast as when it rains.

It has a great resemblance to the *Paspalum laeve* figured and described in the Annual Report for 1879. (See Plate I.)

SETARIA ITALICA.—Hungarian grass, Millet.

This grass is too well known to need an extended description. It has long been cultivated as a fodder grass, both in Europe and in this country. It is supposed to be a native of the East Indies, but has been extensively introduced into most civilized countries. With us it is known as Hungarian grass and millet.

It is an annual grass, of strong, rank growth, the culms erect, 2 to 3 feet high, with numerous long and broad leaves, and a terminal, spike-like, nodding panicle, 4 to 6 inches long, and often an inch or more in diameter. This panicle is composed of a vast number of small crowded branches, each of which is composed of a small group of flower spikelets, at the base of each of which there spring two or three bristles, sometimes short and sometimes so long as to give the head a very bristly appearance. These bristles are roughened or barbed by numerous teeth-like processes on the margin pointing toward the apex. The spikelets are about 1 line long, with three membranaceous, smoothish glumes, the lower one about one-third as long as the others; the grain-bearing glumes and palets are coriaceous and hard, ovate or oblong-ovate, and finely punctate.

The grass owes its value as a fodder plant to the abundance of its foliage, and to the large quantity of seed produced in the panicle.

Great objection has been made, in some instances, to this grass, on account of the stiff bristles which surround the seed spikelets, and which are said to penetrate the stomach of cattle and cause inflammation and death. (See Plate II.)

SETARIA GLAUCA.—Foxtail, Bottle grass.

This is an annual of the same genus as the preceding. It is a native of most tropical and many temperate regions, and has been introduced into most cultivated fields, springing up after the cutting of wheat and early grain, and making its growth in the latter part of the season.

It grows about 2 feet high, with leaves 6 to 9 inches long, ¼ inch wide, smooth, except a few hairs on the margin, toward the base.

The panicle is terminal, cylindrical, 2 or 3 inches long, and about ½ inch wide, dense and spike-like from the numerous very short branches or clusters of flowers. These clusters consist of from one to three spikelets, having at the base of each a cluster of from six to twelve bristles, which are ¼ to ½ inch long, and very finely barbed. When mature they assume a tawny yellow color. The spikelets are a little over a line long, ovoid. The lower glume is short, the second twice as long, and the third about as long as the perfect flower, and containing within it a male flower. Next is the flowering glume, of a hard coriaceous texture, smooth, and marked with fine transverse wrinkles. This incloses the palet of the fertile flower, which is similar in texture to the flowering glume.

This species and *Setaria viridis*, or green foxtail, commonly both grow together in cultivated grounds, often yielding a fair but inferior crop of hay. Birds and poultry are very fond of the seeds, and turkeys are said to fatten on them. (See Plate III.)

MILLIUM EFFUSUM.—Wild Millet.

This is a perennial, rather slender grass, often 4 to 5 feet high, growing in damp woods in the northern portions of the United States and in Canada. It is also found in Northern Europe and in Russian Asia. There are from four to six joints to the culm, each provided with a leaf which is broad and flat, 6 to 12 inches long, and ½ inch wide, smooth above and roughish below. The sheaths are long and smooth. The panicle is loose and spreading, 6 to 10 inches long, the slender rays mostly in fives, of unequal length, the longer ones 2 to 3 inches, and flowering near the extremities. The whorls are from 1 to 2 inches apart. The spikelets are single-flowered, consisting of a pair of thin, concave, smoothish, empty glumes, 1 to 1½ lines long, rather exceeding the flowering glume, which is thick and hard, very smooth and shining, and inclosing the palet, which is of similar texture.

The flowers are in structure similar to those of *Panicum*, to which this grass is closely related.

Hon. J. S. Gould, in the Report of the New York State Agricultural Society, says respecting this grass:

> Mountain meadows and borders of streams; cold woods. It thrives when transplanted to open and exposed situations. It is one of the most beautiful of the grasses; the panicle is often a foot long, and the branches are so exceedingly delicate that the small glossy spikelets seem to be suspended in the air. Birds are very fond of the seed. Mr. Coleman says that he has raised three tons to the acre of as good nutritious hay as could be grown from it when sown in May. The plants multiply by the roots as well as by the seed, sending out horizontal shoots of considerable length, which root at the joints as they extend. (See Plate IV.)

ALOPECURUS PRATENSIS.—Meadow Foxtail.

This is not a native of our country, but has been quite extensively introduced in the Eastern States. It has considerable resemblance to timothy (*Phleum pratense*), but it will be readily distinguished by an examination. It ordinarily grows about 2 feet high, but frequently reaches 3 feet or more in good soil.

The culms are erect, with four or five leaves at pretty uniform distances. The sheaths are long and rather loose, particularly the upper one. The blade of the leaf is 3 or 4 inches long, about ¼ inch wide at the base, tapering gradually to a point. The panicle terminates the stalk and is a cylindrical spike, 2 or 3 inches long, dense, soft, and with

the awns of the flower conspicuously projecting. The spikelets are single-flowered and consist of a pair of empty outer glumes, which are sometimes slightly united at the base, and have a line of short, soft hairs on the keels. These glumes closely inclose the flower, which is of nearly the same length and consists of a flowering glume (formerly called the outer palet) and the essential floral organs. The flowering glume gives rise to a fine awn on its back near the base, which extends 2 or 3 lines beyond the glumes. The proper palet of the flower is wanting, and the stamens and styles are inclosed in the glumes.

Mr. Flint, in his work on grasses, says that it flourishes in Worcester County, Massachusetts, but is nevertheless disliked there as a meadow grass, as it is very light in proportion to its bulk. Mr. J. S. Gould says:

> It flowers in May, nearly four weeks in advance of timothy, and is one of the earliest grasses to start in the spring. Pastures well covered with this grass will afford a full bite at least one week earlier than those which do not have it. It does not flourish in dry soils, but loves moist lands; no grass bears a hot sun better, and it is not injured by frequent mowings, on which account, as well as for its early verdure, it is valuable for lawns. (See Plate V.)

PHLEUM PRATENSE.—Timothy.

This is one of the commonest and best known grasses. For a hay crop it is, perhaps, the most valuable, at least in the Northern States.

The height of the grass depends much on the soil and cultivation. In poor ground it may be reduced to 1 foot, while in good soil and with good culture it readily attains 3 feet, and occasionally has been found twice that height. It is a perennial grass, with fibrous roots. The base of the culm is sometimes thickened and inclined to be tuberous. The culm is erect and firm, with four or five leaves, which are erect, and usually from 4 to 6 inches long. The flower spike varies from 2 to 6 inches in length, is cylindrical, and very densely flowered. The spikelets are single-flowered and cylindrical or oblong in outline. There are two empty glumes, which are equal and rather wedge-form, with a mucronate point or short bristle. The main nerve on the back of these glumes is fringed with a few short hairs. Within the outer glumes is the proper flower, that is, the flowering glume and the palet inclosing the stamens and styles. The flowering glume is shorter than the outer ones, also thinner, 5-nerved, and toothed at the apex. The palet is thinner in texture and much narrower.

This grass, as known in cultivation, is supposed to have been introduced from Europe, but it is undoubtedly indigenous in the mountain regions of New England, New York, and the Rocky Mountains. (See Plate VI.)

AGROSTIS VULGARIS.—Red Top.

A perennial grass, growing about 2 feet high from creeping rootstocks which interlace so as to make a very firm sod. The culms are frequently somewhat decumbent near the base, then upright, smooth, and round, rather slender, and clothed with four or five leaves, which are flat, narrow, and roughish, from 3 to 6 inches long, with smooth sheaths and generally truncate ligules. The panicle is rather oblong in outline, 4 to 6 inches long, open, composed of eight or ten joints or whorls, the lower branches mostly in fives, slender, unequal, the longer ones subdividing at or above the middle. The spikelets are single-flowered, about a line long, varying from greenish to purple. The outer

glumes are lanceolate and pointed, nearly equal in size, smooth except on the keel, which is more or less roughened. The flowering glume is but little shorter than the outer ones, very thin and delicate, and sometimes with a minute awn on the keel. The proper palet is very small, only about half the length of the flowering glume, and inclosing the stamens and styles.

There are several varieties of this species, but there is little practical difference between them. Mr. Gould says:

This is a favorite grass in wet, swampy meadows, where its interlacing, thick roots consolidate the sward, making a firm matting which prevents the feet of cattle from poaching. It is generally considered a valuable grass in this country, though by no means the best one. Cattle eat hay made from it with a relish, especially when mixed with other grasses. As a pasture grass it is much valued by dairymen, and in their opinion the butter would suffer much by its removal.

Mr. S. Howard says there is a smaller variety of this grass, which is found scattered over Massachusetts and Rhode Island, but is chiefly found in the county of Plymouth, Massachusetts. It seldom grows more than 1 foot high, and may be recognized by its narrower leaf and darker color. It yields a less bulk of hay, but is heavier in proportion to its bulk. Another of the varieties is called *Agrostis stolonifera*, from its long, trailing stolons. This variety was at one time greatly in favor in the bog-lands of Ireland, while in England another variety is considered best adapted to dry sandy lands, and is chiefly commended for its ability to withstand severe droughts. (See Plate VII.)

MUHLENBERGIA MEXICANA.—Wood grass.

A perennial grass of rather decumbent habit, 2 to 3 feet high, very much branched from scaly, creeping root-stocks. The culm has numerous short joints below, which are frequently bent, and rooting near the base, and sending out many long, slender, leafy, lateral branches, which give rise from the joints and at the apex to the flowering panicles, which are sometimes partially included in the leaf-sheaths. The leaves are 3 to 4 inches long, and 2 to 3 lines wide, gradually pointed. The panicles are narrow, usually 2 or 3 inches long, and composed of five to ten spike-like branches, closely approximated or becoming distant and interrupted below. The spikelets are single flowered, consisting of a pair of outer empty glumes, which are abruptly sharp-pointed, and nearly as long as the flowering glume, which is narrow, strongly three-nerved, and acute, with usually a few soft hairs at the base and on the nerves. The palet is of equal length, with its glume also acute, but not bristle-pointed.

This grass is frequently found in moist woods and low meadows, or in prairie bogs. It probably would not endure open upland culture, but in its native situations it fills an important part among indigenous grasses.

Professor Killebrew says:

It thrives best in bottoms, where it grows freely. It is slower in maturing than most grasses, and hence fills a vacuum caused by the seeding and dying out of the earlier grasses. It is eaten with avidity by cattle, and is a good grass in its place. (See Plate VIII.)

MUHLENBERGIA SYLVATICA.—Wood grass.

This species in habit and appearance is very much like that of the preceding. The panicle is looser, the spikelets not so densely clustered,

and the flowering glume bears an awn two or three times as long as the spikelet. The glumes are generally bristle-pointed, but they vary much in this respect, in some forms being only acute.

It inhabits drier situations than *M. mexicana*, being found in dry, open, or rocky woods, and fence-corners. In agricultural value it will probably compare well with the preceding species. (See Plate IX.)

CALAMAGROSTIS CANADENSIS.—Blue-joint grass.

A stout, erect, tall, perennial grass, growing chiefly in wet, boggy ground, or in low, moist meadows. Its favorite situation is in cool, elevated regions. It prevails in all the northern portions of the United States, in the Rocky Mountains, and in British America. In those districts it is one of the best and most productive of the indigenous grasses. It varies much in luxuriance of foliage and size of panicle, according to the location. The culms are from 3 to 5 feet high, stout and hollow, hence in some places called the small reed-grass. The leaves are a foot or more long, flat, from a quarter to nearly half an inch wide, and roughish; the stem and sheaths smooth.

The panicle is oblong in outline, open and somewhat spreading, especially during flowering, from 4 to 6 or even 8 inches in length, and 2 to 4 inches in diameter; of a purplish color; the branches mostly in fives, at intervals of an inch or less. The branches of the panicle vary in length from 1 to 3 inches, the long ones flowering only toward the extremity. The spikelets are single-flowered and short-pedicelled; the empty glumes are about 1½ lines long, lanceolate and acute; within, at the base of the flowering glume, are a great number of silky, white hairs about as long as the glume, a part of these hairs forming a tuft which is considered to be the rudiment of a second flower. The flowering glume (lower palet of the books) is thin and delicate, about as long as the outer glumes, and somewhat finely toothed at the summit, 3 to 5 nerved, and bearing on the back, below the middle, a delicate awn, reaching about to the point of the glume, and not much stouter than the hairs. The proper palet (upper palet of the books) is thin, oblong, and about two-thirds the length of its glume.

Mr. J. S. Gould says—

> It constitutes about one-third of the natural grasses on the Beaver Dam meadows of the Adirondacks. It is certain that cattle relish it very much, both in its green state and when made into hay, and it is equally certain that the farmers who have it on their farms believe it to be one of the best grasses of their meadows. (See Plate X.)

BUCHLOE DACTYLOIDES.—Buffalo grass.

Several different grasses have in the Rocky Mountain region received the name of buffalo grass, but that to which the name most properly applies is the *Buchloe dactyloides*, which is extensively spread over all the region known as the Great Plains. It is a very low grass, growing in extensive tufts or patches and spreading largely by means of stolons or offshoots similar to those of the Bermuda grass (*Cynodon dactylon*), these stolons being sometimes 2 feet long, and with joints every 3 or 4 inches, frequently fruiting at the joints. The leaves of the radical tufts are 3 to 5 inches long, 1 or 1½ lines wide, smooth, or edged with a few scattering hairs. The flowering culms are chiefly diœcious; that is, the flowers of one plant all male, and those of another all female. Sometimes, however, both kinds of flowers are found on the same plant, but in separate parts. The flowering stems of the male plant are 4 to 8 or 10 inches high, generally

longer than the radical leaves, bearing three or four slender leaves and at the summit two to four short contiguous flower spikes, which are half an inch long or less. These spikes consist usually of ten to twelve sessile spikelets, alternate in two rows on the lower side of the flattened scabrous rachis. The spikelets are 2 to 3 lines long, and mostly 2-flowered. The empty glumes are very unequal in size, the upper one being twice as long as the lower, ovate, acute, or mucronate, more developed on one side than on the other, and about as long as the flowering glumes. The flowering glumes and their corresponding palets are nearly equal in size and texture, the glume lanceolate, 3-nerved, rather membranous, and, in the lower flower, pointed with a short awn or mucro. The proper palet is membranous, 2-nerved, 2-keeled, and inclosing the three stamens.

The flowering stalk of the female plant is shorter than the leaves, 1 to 2 or sometimes 3 or 4 inches high, and sometimes almost concealed among the leaves at the joints of the stolons. The sheaths of the two or three uppermost leaves are dilated and inclose the spikes or clusters of female flowers. Of these spikes there are two or three, each consisting of three to five spikelets. The spikelets are single-flowered and of a somewhat complex structure, the parts analogous to those of the male flowers, but thickened, indurated, and modified.

It is hardly necessary to recapitulate the virtues of this widely-celebrated grass. It plays an important part in the feeding and fattening of the vast herds of cattle which have now mostly displaced the buffalo. Whether it can successfully be subjected to cultivation remains to be determined. (See Plate XI.)

AIRA CÆSPITOSA.—Hair-grass.

This is an exceedingly variable species, having a very wide distribution in this and other countries. It is somewhat rare east of the Mississippi, but on the elevated plains and in the Rocky Mountains, also in California and Oregon, it is one of the common bunch-grasses which afford pasturage to cattle and horses. We will confine our description to that form which occurs in the hilly regions of New England and Northern New York.

The culms form tussocks, and grow from 2 to 4 feet high; the leaves flat, linear; the radical ones a foot long, those of the culm 4 to 6 inches. The panicle is pyramidal or oblong, 6 to 10 inches in length, of about six whorls of branches, the lower ones in fours or fives, the upper in twos, 1½ to 3 inches long, capillary and spreading, subdividing below the middle; the spikelets on slender pedicels, each with two perfect flowers, and often with the rudiment or pedicel of a third one.

The empty glumes are membranaceous, with a green keel, and about as long as the flowers, the upper one a little the larger; the flowering glumes have each a tuft of white hairs at the base, are thin, scarious, and delicately nerved, and toothed at the blunt apex; from the back of each, near the base, proceeds a slender awn about as long as its glume, or shorter; the palets are similar in texture and narrower. The panicle is very handsome, presenting a silvery hue and a loose graceful appearance. Mr. J. S. Gould says:

> It is found on the shores of lakes and streams. It has a very unsightly mode of growth, forming large tussocks, which, when numerous, are very difficult to get rid of. Cattle seldom eat the rough, coarse leaves. Hogs seem very fond of this grass, and they are the only animals that appear to enjoy it. It is valued in England and in sporting countries as a cover for game, and is sometimes extensively sown with this object. (See Plate XII.)

ARRHANATHERUM AVENACEUM.—Meadow Oat grass.

A perennial grass of strong, vigorous growth, introduced from Europe, and sparingly cultivated. Culms 2 to 4 feet high, erect, rather stout, with four or five leaves each; the sheaths smooth, the leaves somewhat scabrous on the upper side, 6 to 10 inches long and about 3 lines wide, gradually pointed. The panicle is loose and rather contracted, from 6 to 10 inches in length, rather drooping, the branches very unequal, mostly in fives, the longer ones 1 to 2 inches, and subdivided from about the middle; the smaller branches very short, all rather full-flowered. The spikelets are mostly on short pedicels, the branches and rachis rough. The structure of the flowers is similar to that of the common oats (*Avena sativa*), but differs in several particulars. The spikelets consist of two flowers, the lower of which is staminate only, the upper one both staminate and pistillate, and a minute extension of the rachis called a rudiment of a third flower. The outer or sterile glumes are very thin and transparent, the upper one of the two being about 4 lines long and 3-nerved, and the lower one about 3 lines long and 1-nerved. The flowering glume of the lower flower is about 4 lines long, green, strongly 7-nerved, acute, and roughish, with a cluster of hairs at the base; the middle nerve gives rise, near the base, to a twisted and bent awn, which extends conspicuously beyond the spikelet. The proper palet of this flower is thin, linear, and minutely 2-toothed. The second flowering glume is similar to the first, less strongly nerved, and furnished on the back or mid-nerve, near the apex, with a short, straight, appressed awn, hardly extending beyond the glume. This glume has also a small tuft of hairs at the base. The palet of this flower is similar to that of the first. It will require a small magnifier to bring to view the rudiment.

This grass is not much known in this country.

It is much valued on the continent of Europe for the food of all animals except horses. The herbage is very productive, very early, and rapid in its growth. When growing with other grasses, cattle and sheep eat it very well, but do not like to be confined to it alone.

Mr. Thomas Brigden, of South Lowell, Ala., sends samples of this grass, of which he says:

We obtained seed from the Tennessee Valley, under the name of evergreen grass, and it appears at the present time to be by far the most valuable kind that we have experimented with; it remains green during the winter, and starts into growth very early in spring, making a dense, heavy growth from 20 to 30 inches high, and, as far as at present tested, it stands the summer heat well. (See Plate XIII.)

HOLCUS LANATUS.—Velvet grass, Meadow soft-grass.

This is also a foreign grass, which has been introduced, and is tolerably well established in some places. It is perennial, with a stout, erect culm, 2 to 3 feet high, the leaves and especially the sheaths, densely clothed with soft hairs feeling like velvet. The culm is leafy, the sheaths loose, the upper ones longer than the blade, which is 3 to 6 lines wide and rather abruptly pointed. The panicle is open and spreading, rather oblong in outline, 4 to 6 inches in length. The branches or rays are mostly in twos or threes, much divided and soft hairy. The spikelets are 2-flowered and jointed, with the pedicel just below the empty glumes, which are membranaceous, boat-shaped, much larger than the flowers; the upper one much the broader, 3-nerved, the mid-nerve with a row of hairs on the keel and acutely pointed. Of the two flowers the lower one is much the larger and contains both stamens and pistil; the upper one is staminate only. The flowering glumes are smooth and shining, rather

coriaceous; that of the lower flower awnless, that of the upper one with a short, stout, bent or hooked awn at the apex.

It is not held in good repute as an agricultural grass in Europe. It has frequently been sent to this department from the South with strong commendations for its productiveness. (See Plate XIV.)

PHRAGMITES COMMUNIS.—Reed grass.

A tall, coarse, perennial grass, growing on the borders of ponds and streams, almost rivaling sorghum in luxuriance. It attains a height of 6 to 10 feet, the culms sometimes an inch in diameter and leaves an inch or two in width.

The panicle is from 9 to 15 inches long, loose but not much spreading, of an oblong or lanceolate form, slightly nodding. The branches are very numerous, irregularly whorled 4 to 8 inches long, much subdivided, and profusely flowering. The larger panicles form very ornamental plumes, almost equal to those of *Arundo donax*, so much cultivated for ornament. The spikelets are from 3 to 7 flowered, all the flowers except the lowest surrounded by long silky hairs at the base; the lowest one is either empty or contains only stamens. The lower or empty glumes are thinnish, lanceolate, keeled, and unequal in size, the upper one being considerably the longer. The flowering glumes are membranaceous, narrowly awl-shaped, and about as long as the silky hairs. The palets are thin and only half to one-third as long as their glumes.

This grass is widely distributed in different parts of the globe, and in some countries is put to several uses, as for thatching, for which purpose it is said to be valuable. It is also used for making light reed fences and screens. Its leaves are too coarse and innutritious for fodder. (See Plate XV.)

MELICA MUTICA.—Melic grass.

A perennial grass, growing sparingly in rich, rocky woods throughout most of the States east of the Rocky Mountains. It grows in loose tufts, the culms about 2 feet high, the lower leaves and sheaths soft hairy, the upper leaves narrow, 3 to 4 inches long, gradually pointed.

The panicle is nearly simple or little branched, or in the variety *diffusa* the panicle is larger, more branched and spreading. The spikelets are loosely arranged on the branches, almost sessile, and rather on one side of the branches. They are large and graceful in appearance, each one consisting of two perfect flowers and a small chaffy knob called a rudiment. The outer glumes are thin, scarious-margined, 5 to 7 nerved, purplish, and 3 to 4 lines long. The flowering glumes are thicker, strongly ribbed, scarious at the blunt apex, and minutely rough on the nerves. The two flowers are somewhat distant from each other. The palets are narrower and shorter than the flowering glumes, arched and ciliate on the keels.

This grass is eaten and relished by cattle, but is not probably well adapted to cultivation. (See Plate XVI.)

GLYCERIA CANADENSIS.—Rattlesnake grass.

A grass belonging to the northern portion of the United States, usually found in mountainous districts, in swamps, and river borders, growing in clumps. The culms are stout, about 3 feet high, smooth and leafy. The leaves are linear-lanceolate, 6 to 9 inches long, or the lower ones much longer, about 4 lines broad, and rather rigid. The panicle is large and effuse, 6 to 9 inches long, oblong-pyramidal, and at length

drooping. The whorls are an inch or more distant, the branches semi-verticillate, mostly in threes, the largest 3 to 4 inches long, and subdivided from near the base. The spikelets are oblong to ovate, when mature nearly 3 lines long, rather turgid, but flattened at the sides, usually 6 to 8 flowered. The empty glumes are shorter than the flowering glumes, ovate-lanceolate, acute, purplish, the upper one largest. The flowering glumes are broadly ovate, acute, 5 to 7 nerved, $1\frac{1}{2}$ to 2 lines long. The palets are shorter than their glumes and thicker in texture, roundish and obtuse, with the sides strongly reflexed.

This is quite an ornamental grass, resembling the *quaking grass* (*Briza*). Cattle are fond of it both green and when made into hay. It is well adapted to low meadows. (See Plate XVII.)

POA ALSODES.

A species of spear-grass, of, probably, no great agricultural value, but found in mountainous districts in the northern parts of the United States, in woods and on hill-sides in New England, New York, the mountainous parts of Pennsylvania, and westward to Wisconsin.

The culms are 2 to $2\frac{1}{2}$ feet high, slender, erect, and with about three narrowly linear leaves, each 3 to 4 inches long. The panicle is about 6 inches long, very open, and composed of about four whorls of branches, chiefly in fours, the lower ones distant, very slender, 2 to 3 inches long, and with few flowers only toward the extremity of the branches. The species may most readily be distinguished by the *acute* flowers. The spikelets are about 2 lines long, chiefly 3-flowered. All the glumes are acutely pointed, the flowering ones obscurely nerved, and with a narrow tuft of long webby hairs at the base. Mr. J. S. Gould says:

> It flourishes on mountain-sides from 1,000 to 3,000 feet above the sea; but is very well adapted for lawns and for thick, shady places, where few other kinds will grow. The seeds weigh about 15 pounds to the bushel. (See Plate XVIII.)

ERAGROSTIS POÆOIDES var. MEGASTACHYA.

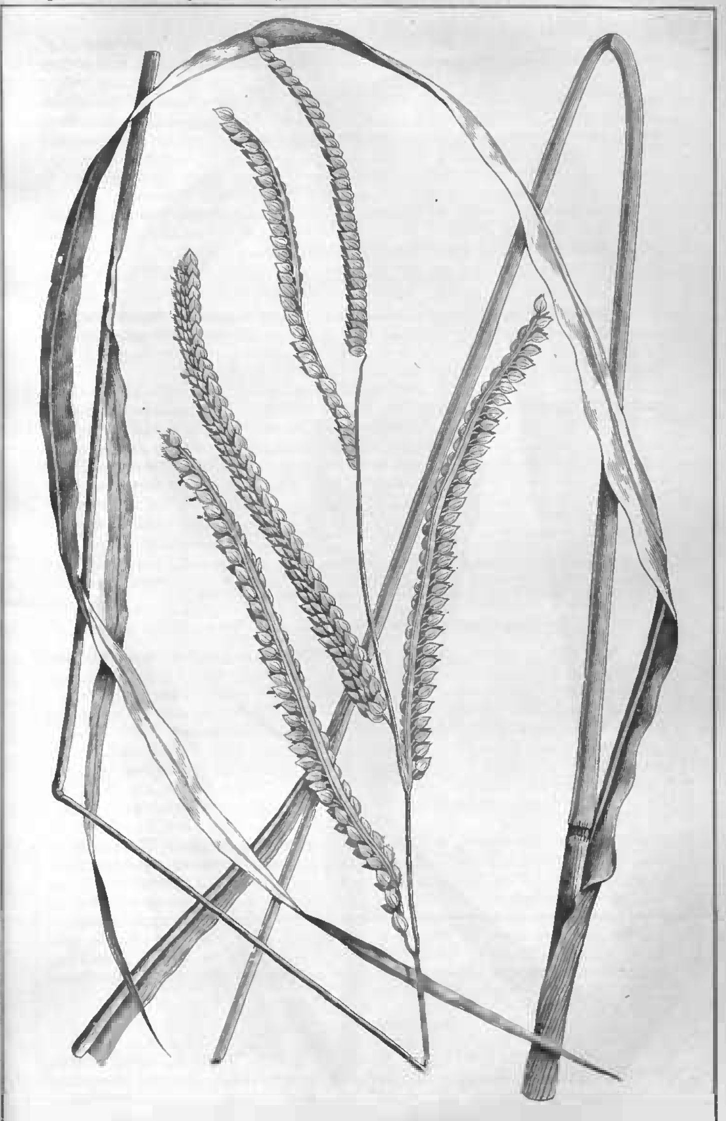
This is an European grass which has become extensively naturalized, not only in the older States, but in many places in the Western and Southwestern Territories. It is found in waste and cultivated grounds and on roadsides, growing in thick tufts, which spread out over the ground by means of the geniculate and decumbent culms.

The culms are from 1 to 2 feet long, the lower joints bent, and giving rise to long branches. The sheaths are shorter than the internodes, the leaves from 3 to 6 inches long. The panicle is frequently 4 or 5 inches long, oblong or pyramidal, somewhat open, but full-flowered, the branches irregularly single or in pairs, branched and flowering nearly to the base. The spikelets are oblong or lanceolate, $\frac{1}{4}$ to $\frac{1}{2}$ inch long and 10 to 20 flowered when well developed. The empty glumes are smaller than the flowering ones, rough on the keel, acutish. The flowering glumes are 1 line long, ovate, rather obtuse, and strongly 3-nerved. The palets are shorter than their glumes, narrow, the sides reflexed, and the margin ciliate.

This grass is said to have a disagreeable odor when fresh. It produces an abundance of foliage, and is apparently an annual, reaching maturity late in the season. We are not aware that its agricultural value has been tested. (See Plate XIX.)

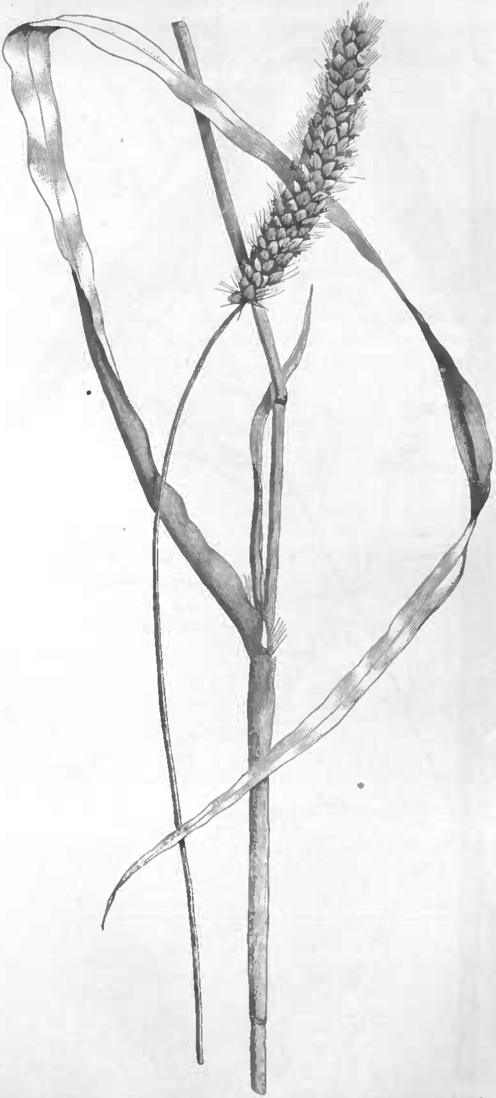
ERAGROSTIS PURSHII.

This is a native grass very widely diffused over the United States, and extends into Mexico. In habit it is somewhat like the preceding



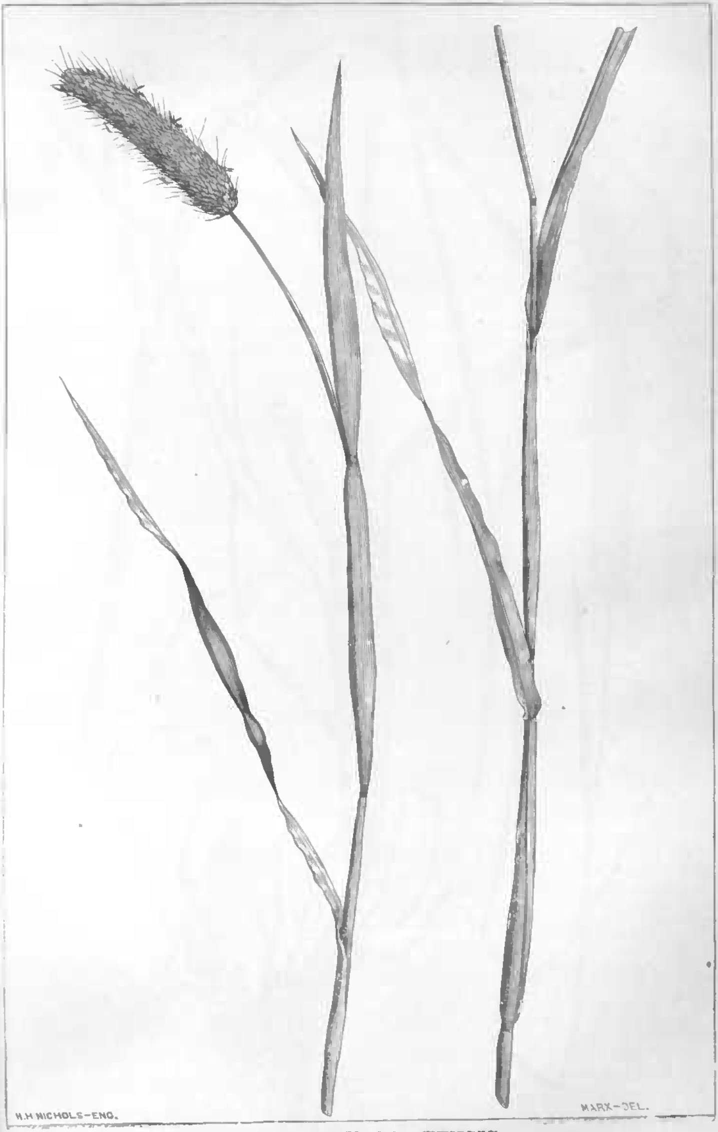
PASPALUM OVATUM.

SETARIA ITALICA.



SETARIA GLAUCA,

MILIUM EFFUSUM.



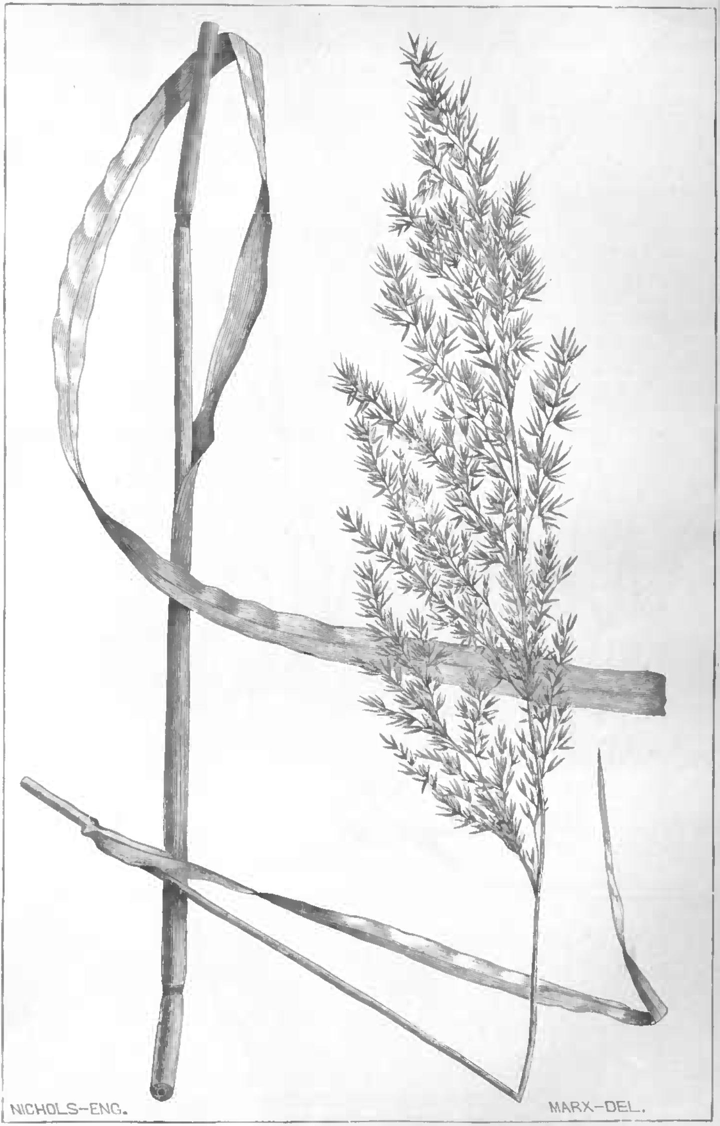
ALOPECURUS PRATENSIS,

PHLEUM PRATENSE.

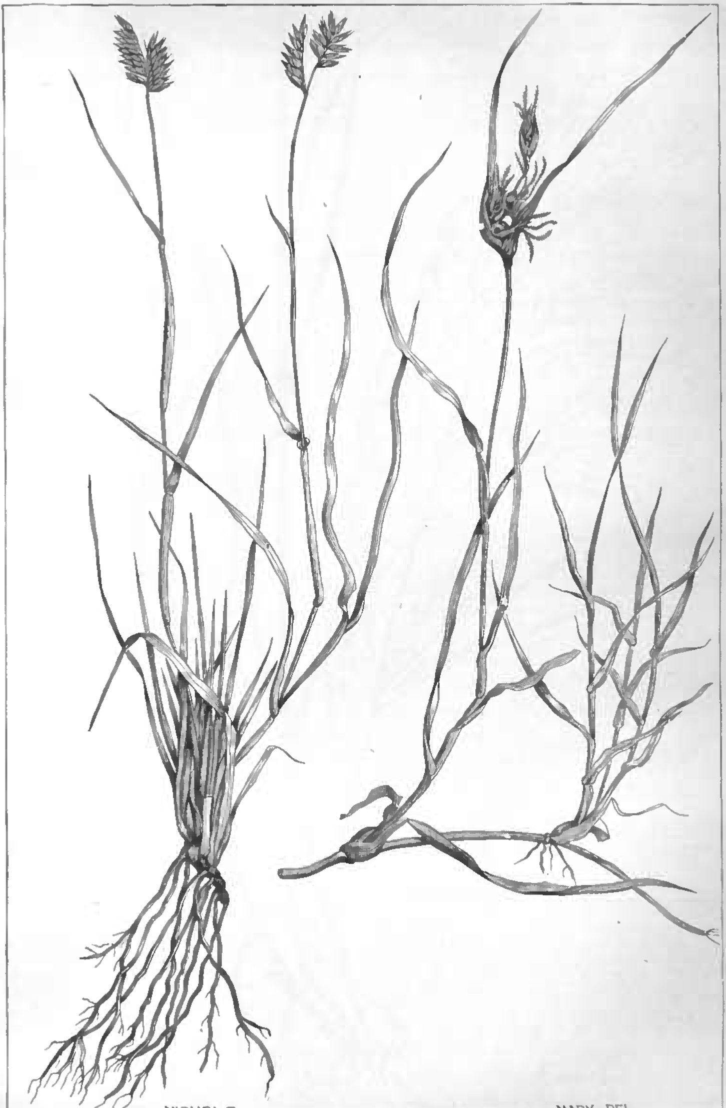
AGROSTIS. VULGARIS.

MUHLENBERGIA MEXICANA.

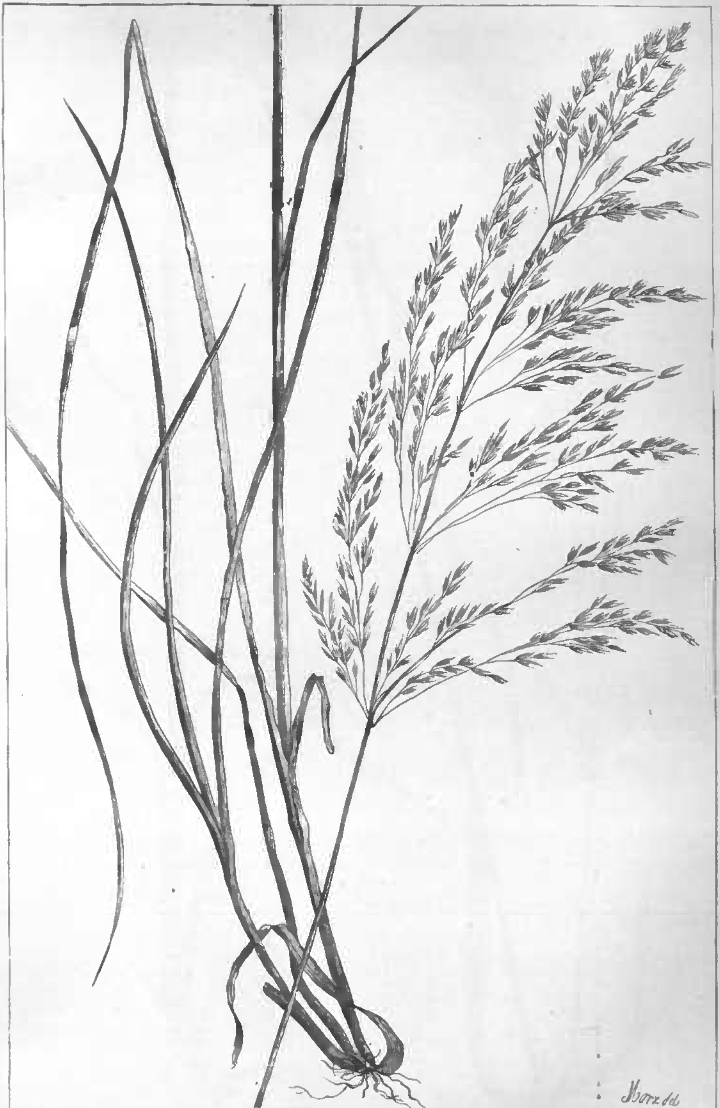
MUHLENBERGIA SYLVATICA.



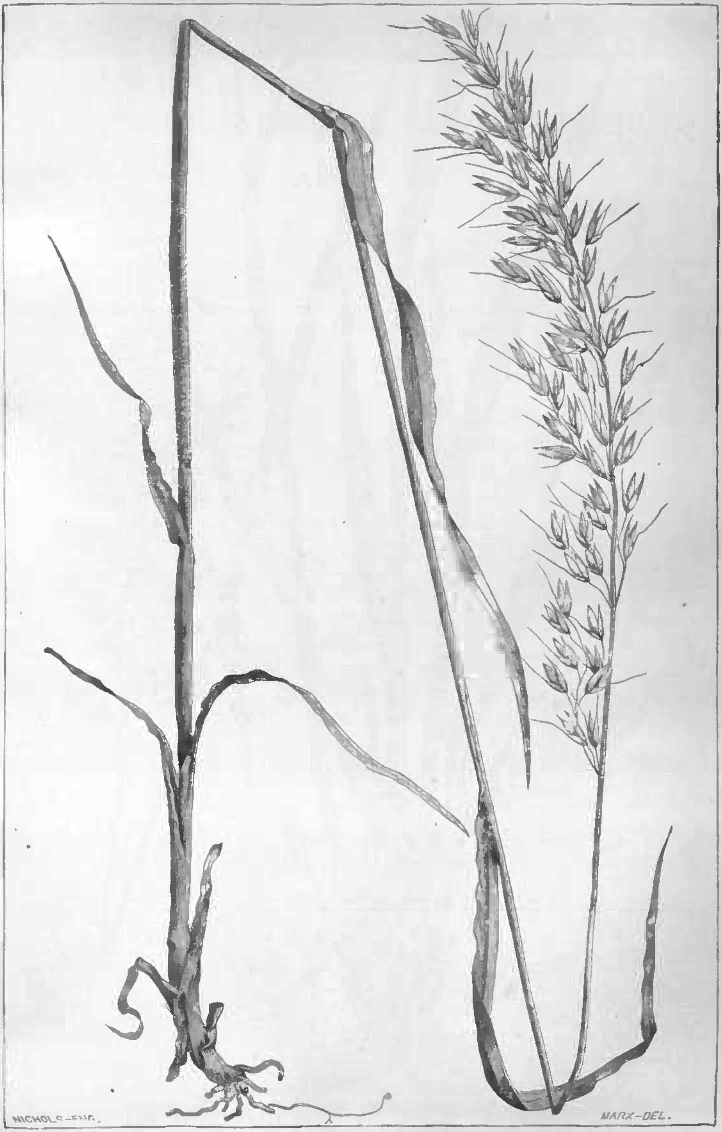
CALAMAGROSTIS CANADENSIS.



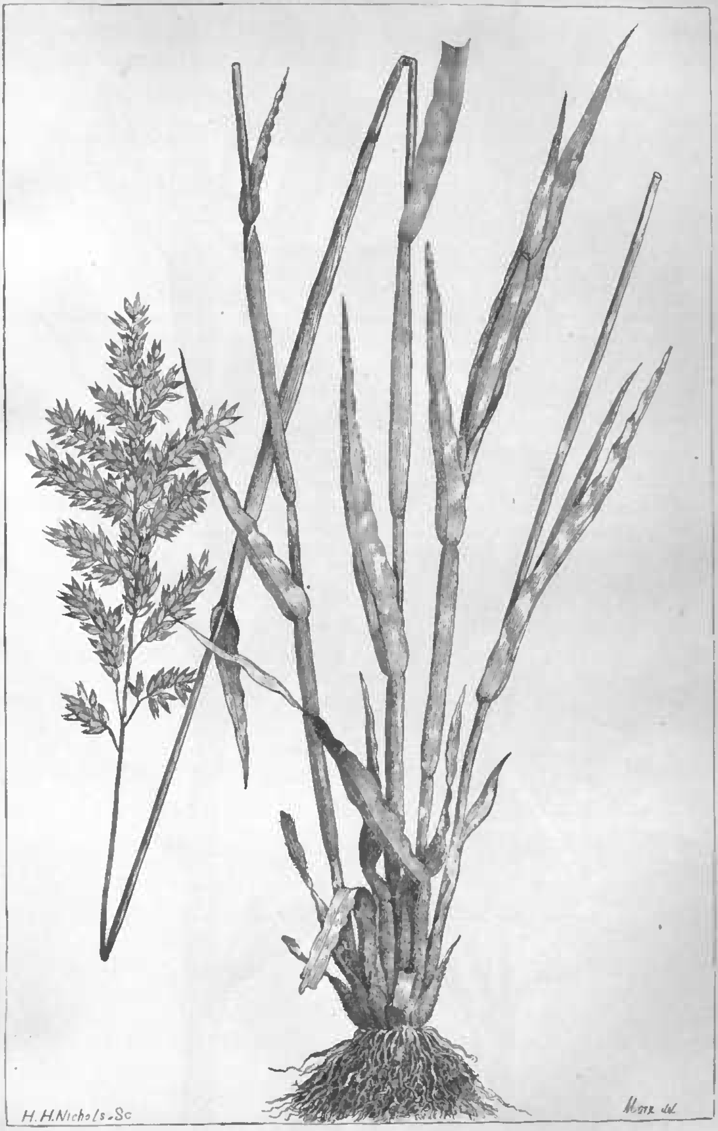
BUCHLOE DACTYLOIDES.



AIRA CÆSPITOSA.



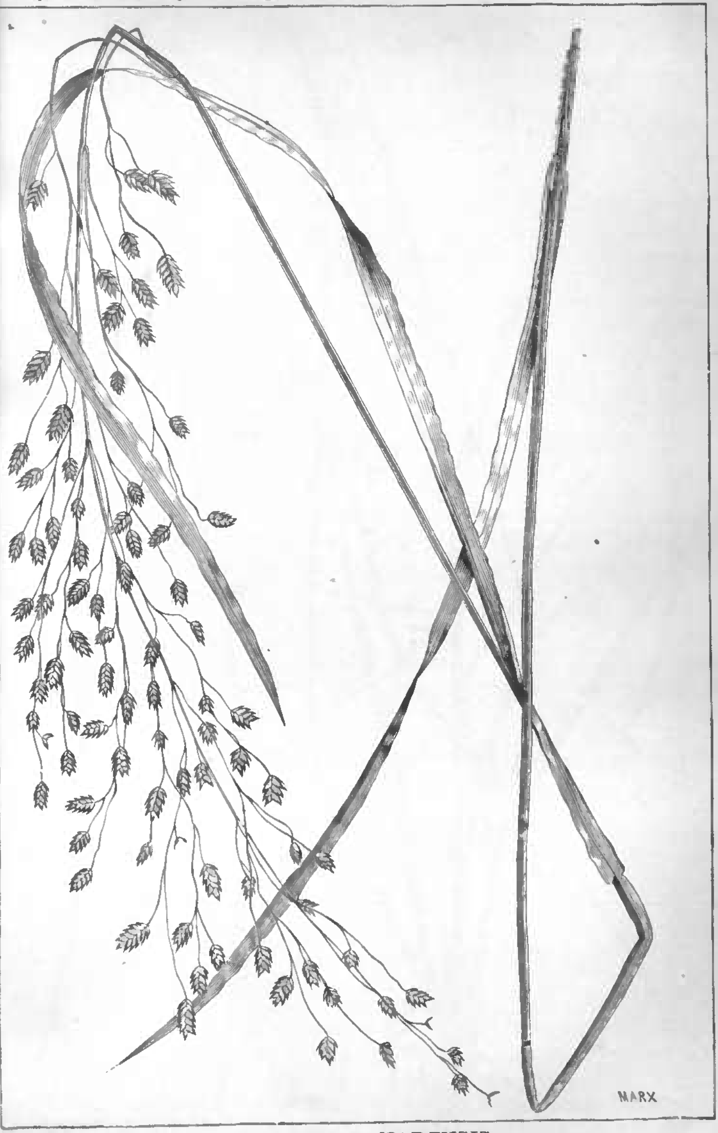
ARRHENATHERUM AVENACEUM.



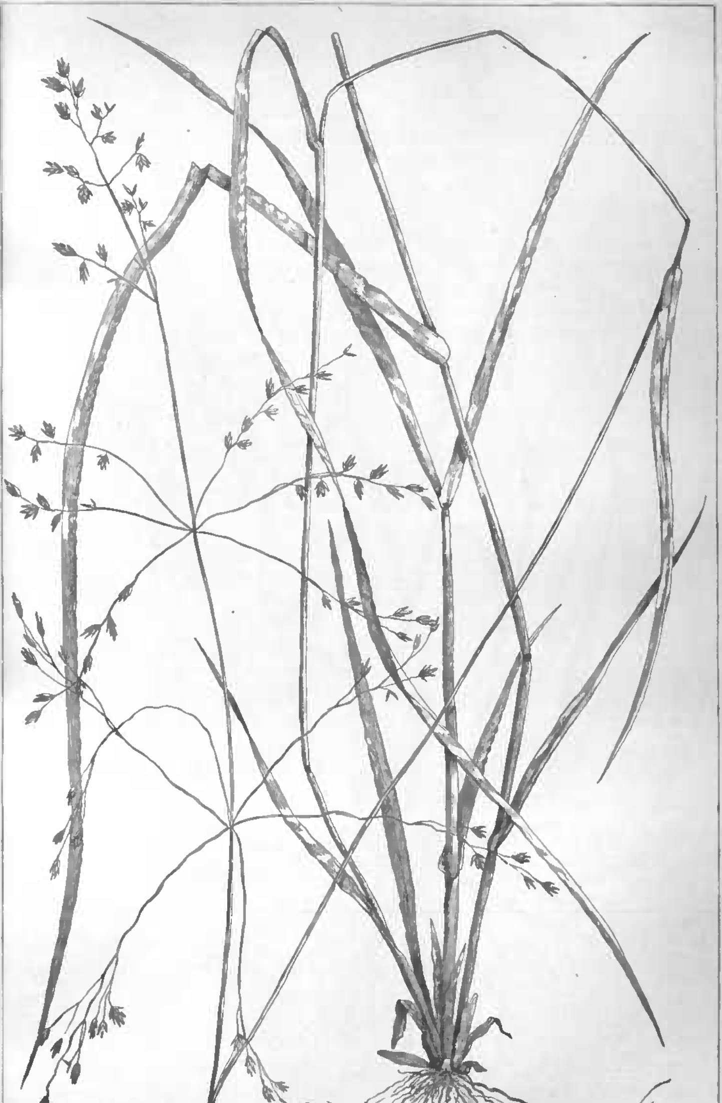
HOLCUS LANATUS.

PHRAGMITES COMMUNIS.

MELICA MUTICA.

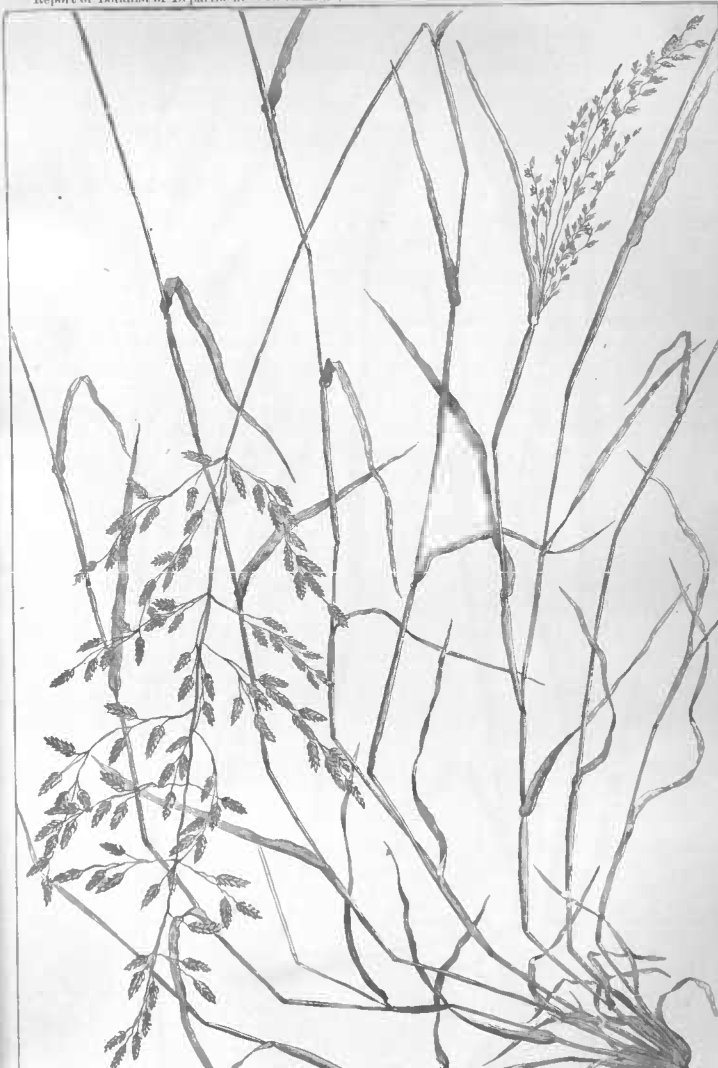


GLYCERIA CANADENSIS.



POA ALSODES.

ERAGROSTIS POÆOIDES.

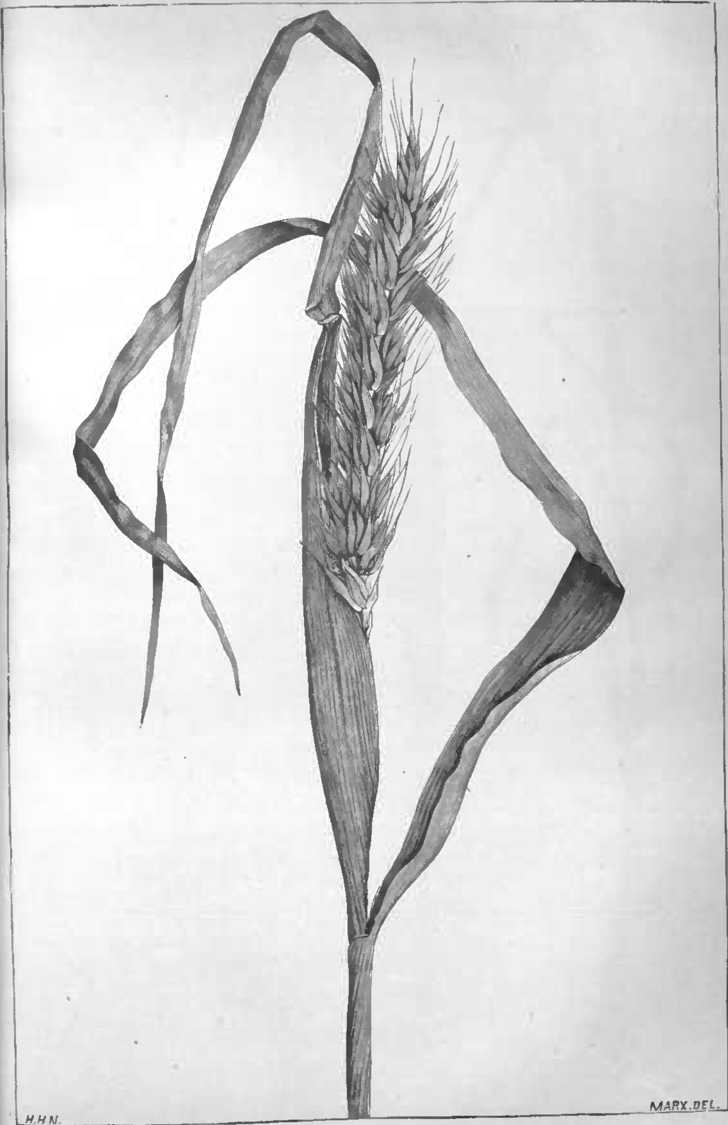


ERAGROSTIS PURSHII.

BROMUS ERECTUS.

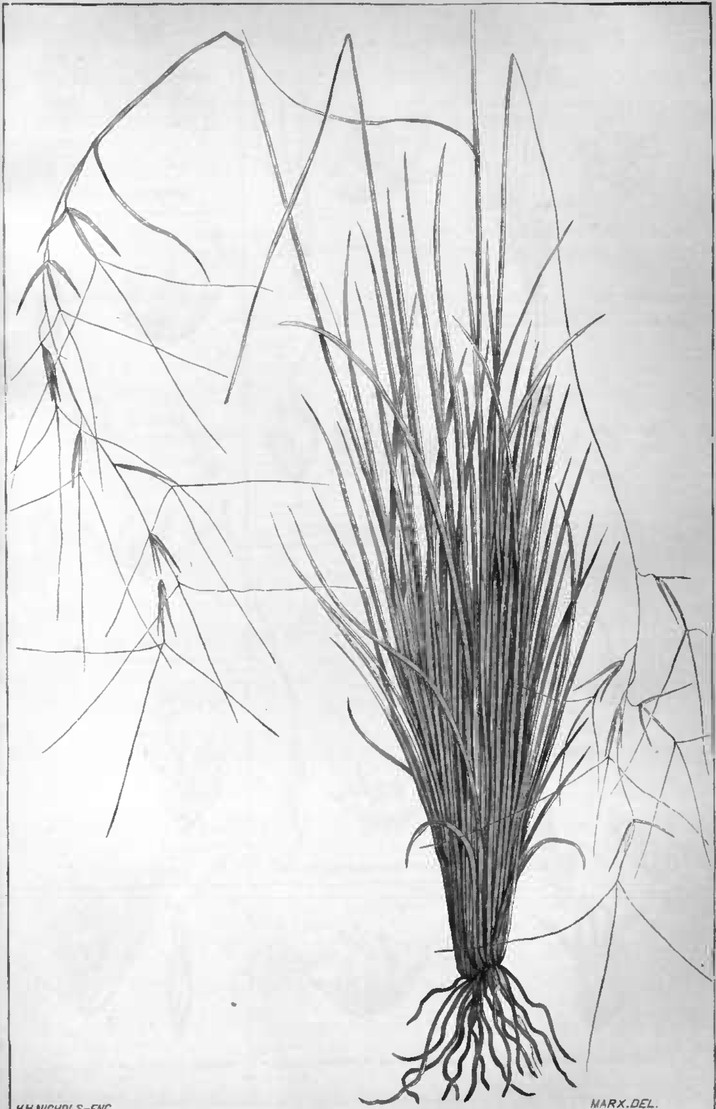
LOLIUM PERENNE.

HORDEUM NODOSUM.

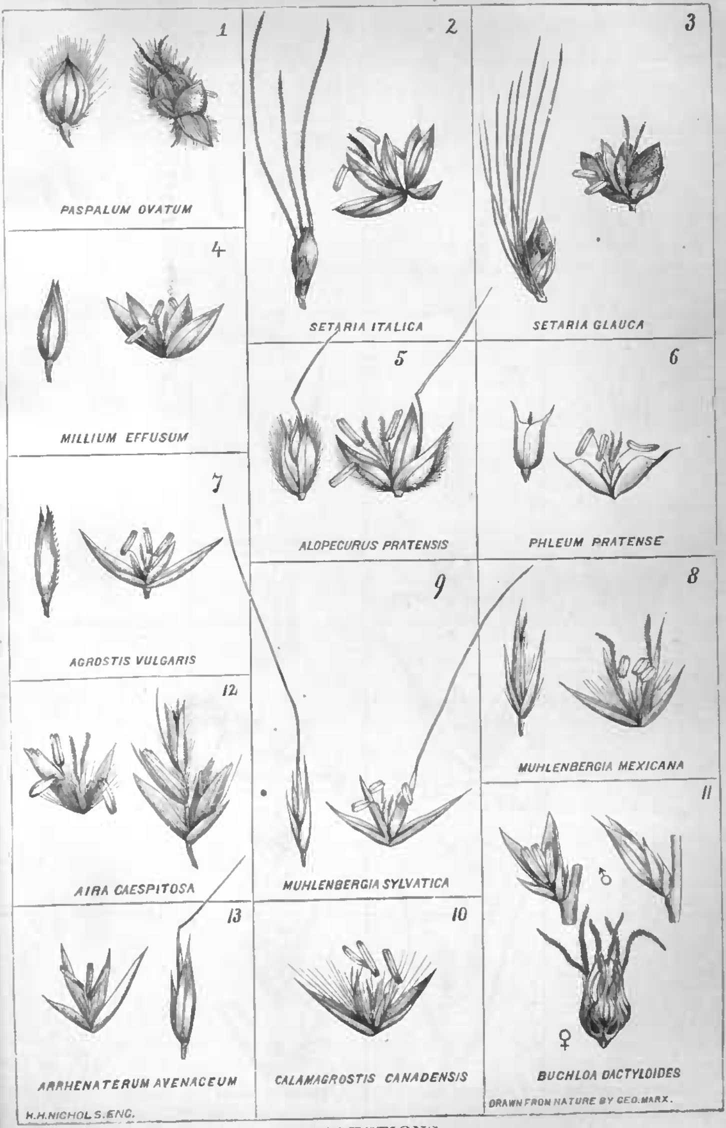


ELYMUS VIRGINICUS.

ELYMUS STRIATUS.



ARISTIDA PURPUREA.



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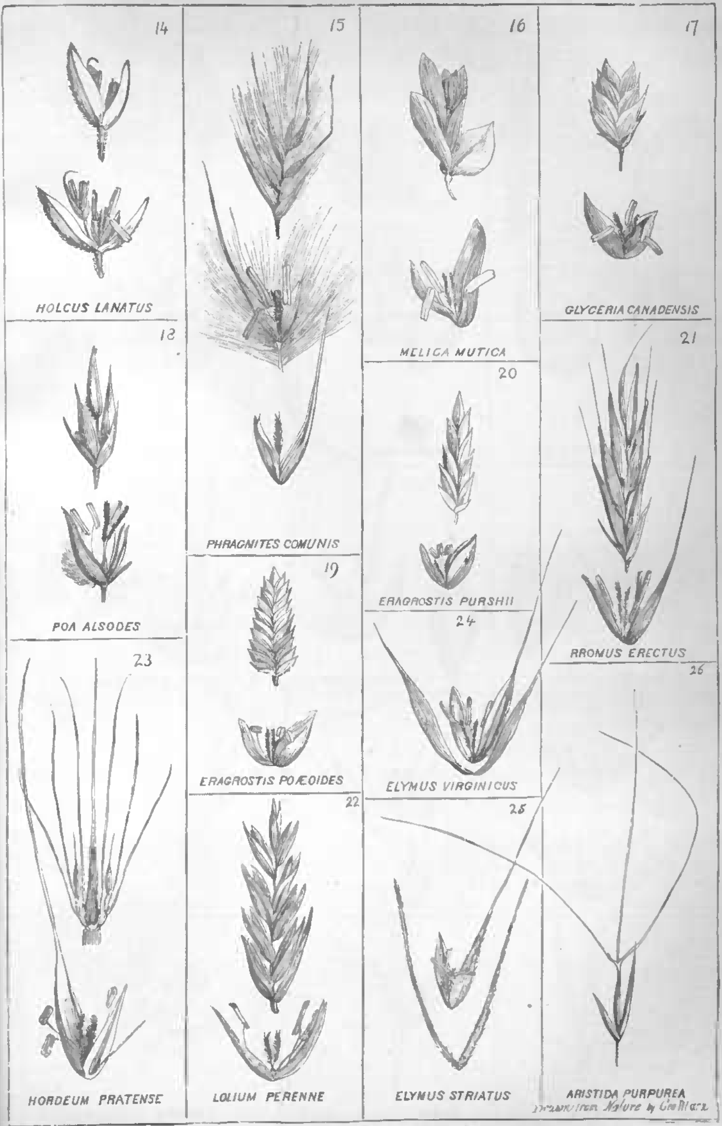

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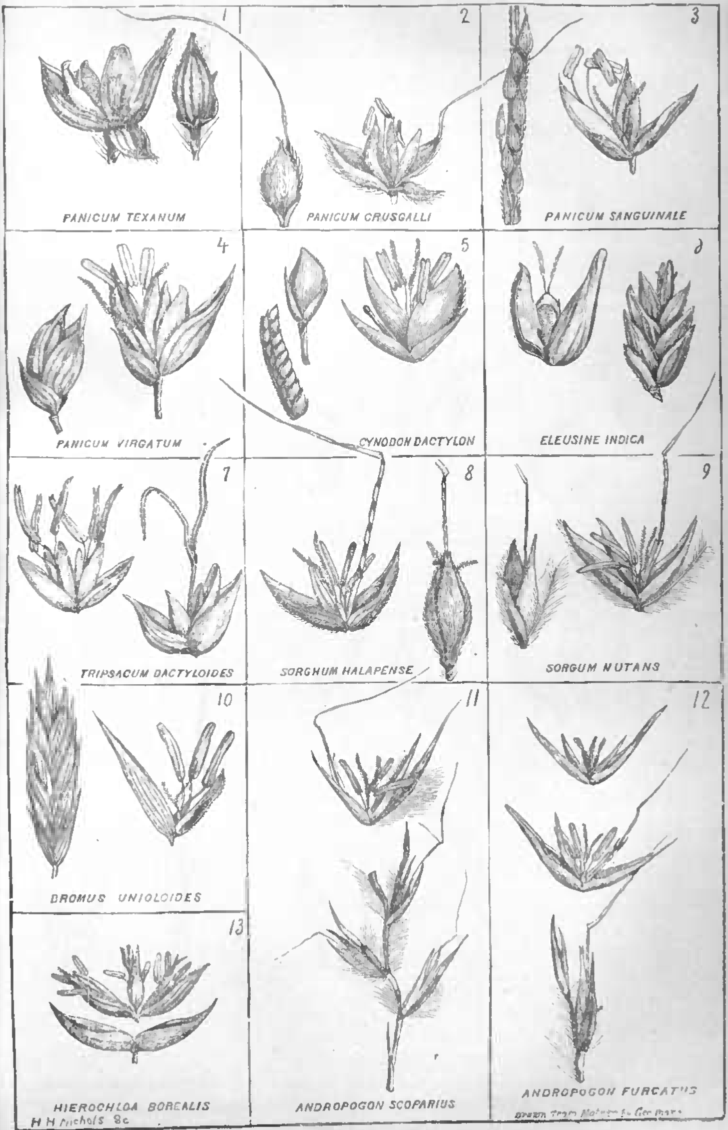

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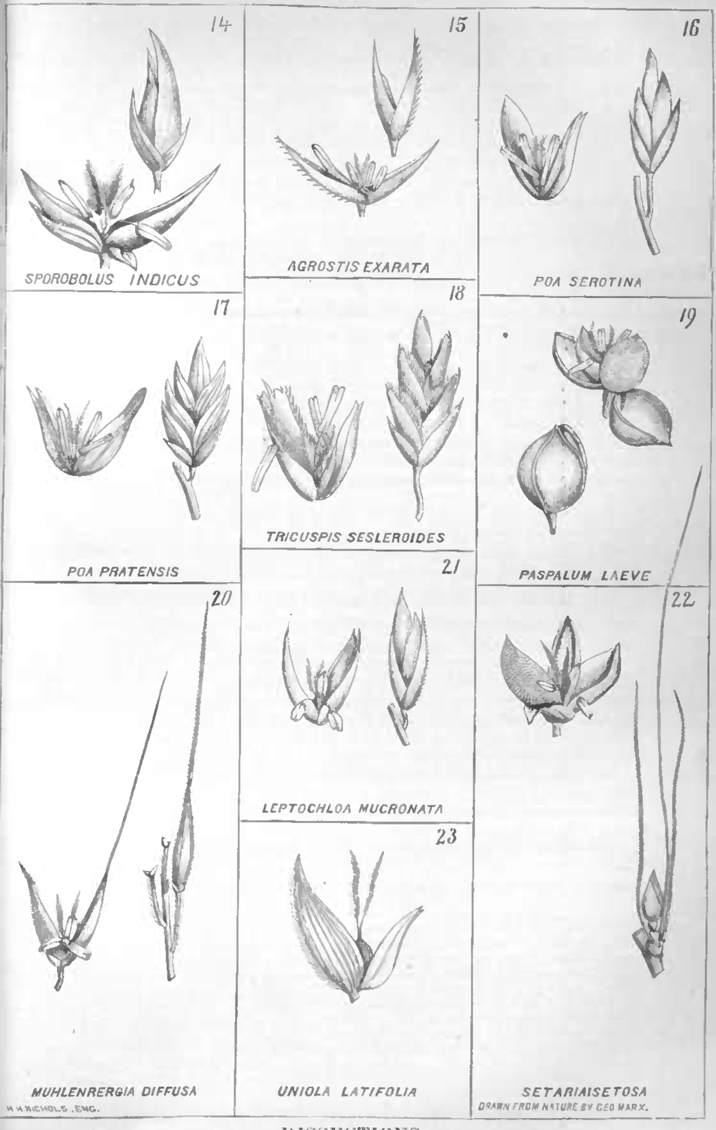

DISSECTIONS.

species (*E. poæoides*), growing in tufts, with the culms branching at the base, and the lower joints bent. The culms are smooth, slender, 10 to 20 inches high, the leaves narrow and sparse, with a tendency to produce an abundance of flowering culms. The panicle is oblong, open and spreading, 3 to 4 inches long, with the branches irregularly single or in pairs, and much subdivided. The spikelets are oblong, lanceolate to linear, about 2 lines long, and usually from 5 to 15 flowered. The empty glumes are small, only about half the length of the flowering glumes, ovate and acute. The flowering glumes are about half a line long, acutish, and distinctly 3-nerved.

It has little or no agricultural value except in arid, sandy districts, where it seems to be most common. (See Plate XX.)

BROMUS ERECTUS.—Erect Brome grass.

This is an European species which has become sparingly naturalized in some places. It is a perennial grass, growing about 2½ feet high, the culms erect, firm, and smooth. The leaves are narrowly linear, mostly radical or at the base of the stem. The panicle is somewhat oblong in outline, 5 or 6 inches long, the branches mostly in fives, 1 to 2 inches long, slender, erect, not much subdivided, and each terminated with the pretty large spikelet of seven to nine flowers. The spikelets are about 1 inch long. The empty glumes are lanceolate, thinnish, acute, rather shorter than the flowering glumes, which are about 5 lines long, linear-lanceolate, slightly rough, and pointed with an awn of half to three-quarters its own length.

This species is not so coarse as many of the brome grasses, and will be more useful for hay. It is of the same genus as chess or cheat, but is very different from and should not be confounded with broom grass, which is an *Andropogon* and much less valuable. (See Plate XXI.)

LOLIUM PERENNE.—Rye grass, and Italian Rye grass.

A perennial grass introduced from Europe. The culms are 2 to 3 feet high, very leafy, and terminating in a loose spike-like panicle, 6 inches or more in length. The spikelets are arranged alternately on the rachis, placed edgewise, that is, with one edge of the flat spikelet applied to the main stem, at short distances, so that there may be twenty or more in the panicle. The spikelets are ½ to ¾ inch long, generally 7 to 11 flowered. The inner empty glume is generally wanting, so that, except on the terminal spikelet, only one glume is apparent, which is half or more than half the length of the spikelet, narrowly lanceolate, and acute. The general appearance of the panicle is like that of couch grass (*Triticum repens*). The flowering glumes are thickish, obscurely nerved, rather hispid, acutely pointed, or in the variety *Italicum* with a longish awn. The proper palets are similar to the flowering glumes and of nearly equal length.

An intelligent writer, whom we have frequently quoted, says, respecting this grass:

> It occupies the same place in Great Britain that timothy does with us, and is there esteemed on the whole higher than any other species of grass, and is called rye grass or ray grass. Of all the varieties of *Lolium perenne* which are known, that called *italicum* is by far the most valuable. Its spikelets are conspicuously bearded, the flowers being all terminated by long, slender awns, which character distinguishes it very easily from *Lolium perenne*. Its name (Italian rye grass) is derived from the fact that its native habitat is on the plains of Lombardy, where broad and extensive plains of pasture land are frequenlty inundated by the mountain streams which intersect them. It is mainly adapted to irrigated meadows, and in these it is undoubtedly superior to any other grass. (See Plate XXII.)

HORDEUM NODOSUM.—Barley grass; Meadow barley.

An annual or biennial grass, growing principally in alkaline soils and on the borders of saline marshes, especially in the Western States and Territories. Although eaten by cattle when in a young state, it cannot be claimed as of anything more than temporary value. The culms are usually 1 to 1½ feet high, sometimes in moist places reaching 3 feet, and varying as to smoothness or pubescence. The leaves are usually flat, 2 to 4 inches long, and about 2 lines wide. The flowers are in a close, cylindrical spike, about 2 inches long, with three spikelets at each joint of the rachis. One (the central) spikelet is sessile and perfect; the two lateral ones are short-stalked and imperfect or abortive. Each of the spikelets has a pair of empty glumes, which are narrowly lanceolate and awn-pointed, or the lateral ones may be reduced to rough bristles. The flowering glume of the perfect flower is lanceolate, indistinctly 3-nerved, and terminated by an awn ¼ to ½ inch long, equaling those of the empty glumes. The proper palet is inclosed in its glume, is of about the same length as that, excluding the awn, and of thinner texture. (See Plate XXIII.)

ELYMUS VIRGINICUS.—Wild Rye grass.

A coarse perennial grass, growing on alluvial river banks or in rich low grounds. The culm is rather stout, 2 to 3 feet high, leafy; the lower leaves are 10 to 15 inches long, broad and rough. The sheath of the upper leaf usually incloses the stalk and sometimes the base of the flower-spike. This spike is erect, dense, and rigid, 2 to 4 or 5 inches long and ½ inch thick. The spikelets are two or three together at each joint, all alike and fertile, sessile, 2 to 5 flowered, and each with a pair of empty glumes. These glumes are very thick and coarse, strongly nerved, lanceolate, and bristle-pointed, about 1 inch long. The flowering-glumes are of firm texture, lance-oblong, 5-nerved, hairy on back, and terminating in a stiff, straight awn, half an inch to nearly an inch long, the lowest one in the spikelet having the longest awn, the others gradually shorter. The palet is oblong, obtuse, and as long as the flowering glume excluding the awn.

This grass frequently forms a considerable portion of the produce of native meadow-lands, and makes a coarse hay. It starts growth early in the spring, and thus affords a good pasturage. Professor Killebrew, of Tennessee, says it is very valuable and ought to be tried in cultivation. (See Plate XXIV.)

ELYMUS STRIATUS.—Smaller Wild Rye grass.

This grass has a structure as to the flower-spike similar to the preceding, but it is a more slender grass in all its parts, varying from smooth to pubescent. The spike is 3 to 4 inches long, cylindrical, and inclined to droop. The glumes are more slender than in *E. virginicus*, with longer awns. The spikelets are usually 2-flowered, the empty glumes narrow, rigid, and about 1 inch long. The body or dilated part of the flowering glume is oblong, about 4 lines long, and tipped with a slender awn an inch or more in length.

This species grows in rocky woods and on river banks, growing more sparsely than the preceding, and it is said by some to furnish a good hay. (See Plate XXV.)

Respectfully submitted.

GEO. VASEY, *Botanist.*

To Hon. W. G. LE DUC,
Commissioner of Agriculture.

INVESTIGATIONS OF SWINE PLAGUE AND FOWL CHOLERA.

SECOND REPORT OF D. E. SALMON, D. V. M.

Hon. Wm. G. Le Duc,
Commissioner of Agriculture:

Sir: I have the honor to submit the following report of investigations, undertaken by your authority, of the diseases known as the swine plague and fowl cholera.

Part I.—INVESTIGATIONS OF SWINE PLAGUE.

By the investigations carried out under your direction in 1878, many important and long-contested questions respecting this disease must be regarded as definitely settled. Among the more important of these I particularize the following, which had a controlling effect on my work during the past year. 1. The great epizoötics among swine in the West and South are the result of one and the same disease. 2. The symptoms and more apparent lesions of this are definitely ascertained. 3. This disease is contagious, and the great majority of cases may be traced to contagion. 4. It may be communicated by inoculation to other species of animals.

There were some other points, however, which still needed much investigation. Most important of all, from a practical stand-point, seemed the necessity of determining the comparative activity of different disinfectants in destroying the virus, in order that an intelligent selection of these might be made in freeing infected premises from the disease and possibly in the treatment of sick animals. It was, also, exceedingly desirable that further microscopic observations should be made with a view of obtaining more substantial evidence in regard to the nature of the contagious principle which constitutes the essential cause of the disease. For, if this disease could be traced to the effects of a microscopic organism with the same certainty as anthrax fever has been traced to the *Bactéridie* or *Bacillus anthracis*, we might be able to discover points in the development history of this which would have as great influence on our sanitary measures as the recent discoveries of Pasteur must have on the prevention of anthrax.

FIRST SERIES OF EXPERIMENTS.

The virus for these inoculations was obtained at Pickens, S. C., December 29, 1879, by killing a sick animal belonging to Mr. Hagood. The disease had prevailed for several weeks, and a few hogs from this gentleman's herd were already dead. Two were sick at the time of my visit. The one selected had been improving for about a week, had a

fair appetite, but still went with arched back, tucked-up abdomen, and staggering walk. Temperature 103⅓° F. Traces of petechiæ and eruption on skin of abdomen and inner side of thighs. The abdomen was distended with a transparent yellowish effusion, in which coagulæ rapidly formed on exposure to the air. Small intestines slightly congested; peritoneum thickened; liver congested; small patches of hepatization in both lungs, and bronchial tubes filled with reddish froth. Mucous membrane of stomach considerably reddened in places; lymphatic glands congested; blood dark colored, but formed a firm coagulum. Vacuum tubes were filled with blood and abdominal effusion and hermetically sealed; pieces of lung, stomach, spleen, and lymphatic glands secured.

EFFECT OF SOLUTION OF CHLORIDE OF ZINC ON THE VIRUS.

In Professor Law's experiments, but one of the agents which he used seemed to be an efficient disinfectant, in solutions of one-fifth of 1 per cent. after a contact of five minutes. This was chloride of zinc.* To make a thorough test of the activity of this agent, and to discover the weakest solution that would prove a safe disinfectant, seven pigs were inoculated, January 3, 1880, as follows:

Experiment No. 1.—One pig inoculated with peritoneal effusion, blood and dried froth from trachea.

Experiment No. 2.—One pig inoculated with one drop of effusion in four of distilled water.

Experiment No. 3.—One pig inoculated with one drop of effusion in four of a solution of chloride of zinc 1:500.

Experiment No. 4.—One pig inoculated with one drop of effusion in four of a solution of chloride of zinc 1:1,000.

Experiment No. 5.—One pig inoculated with one drop of effusion in four of a solution of chloride of zinc 1:3,000.

Experiment No. 6.—One pig inoculated with one drop of effusion in four of a solution of chloride of zinc 1:4,000.

Experiment No. 7.—One pig inoculated with one drop of effusion in four of a solution of chloride of zinc 1:5,000.

Method of preparing the virus.—From one-half to one hour before using, four drops of the solution of chloride of zinc of the required strength were placed in a watch glass; to this was added and thoroughly mixed a single drop of peritoneal effusion. It was then covered with a small bell glass, and allowed to stand till used. In each case the solution had sufficient strength to coagulate the albuminoid constituents of the effusion, and thus produce a white liquid resembling milk. With the solution of 1:5,000 this was less marked than with the others, but still quite noticeable, and it was hoped from this demonstration of the activity of the diluted solution, that it might prove effective in destroying the virus when in contact with it for a considerable time. As we shall soon see, this hope was not realized.

Method of inoculation.—To prevent constant disinfection of the lancet, virus treated with the stronger solutions was first used, and the pure virus inoculated last; that is, the inoculations were made in the following order, according to the numbers of the above experiments: No. 3, 4, 5, 6, 7, 2, 1. Of course, if the virus were destroyed at all this would happen with the strongest solution, and the contamination of the lancet would, therefore, have no effect on the results. In each case the grooved lancet was used, one drop of virus being inserted in each of two punctures in the ear, and one drop in a single puncture on inside of thigh.

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* Report of Commissioner of Agriculture, 1878, p. 378.

Distribution of animals.—The animals, numbered to correspond with experiments, were, for convenience in feeding, with one exception, placed two in each pen. Thus, Nos. 1 and 2 were placed in pen No. 2; Nos. 3 and 4 in pen No. 1; Nos. 5 and 6 in pen No. 3; and No. 7 in pen No. 4. The pens were at least 100 feet apart, and it was believed that, in case one of the inmates of a pen should contract the disease from the other, the difference in the time of appearance of the first symptoms would make this apparent.

Results.—Not one of these pigs escaped the infection. January 12, No. 1 had eruption; No. 2 was coughing; No. 4 coughing, with high temperature. January 15, all have a plain eruption, most noticeable on the inner sides of thighs and fore-legs. Temperature of No. 4 still high ($104\frac{1}{4}°$), but that of No. 7, though covered with eruption, is but $98\frac{1}{2}°$.

January 17.—No. 4 killed for examination. The skin covered with elevations of considerable size, and very apparent; granular melanotic deposits in the areolar tissue beneath abdomen; mesentery thickened, and intestines united as the result of peritonitis; elevations on mucous surface of duodenum; congested patch on mucous membrane of stomach; liver congested and softened; spleen reddened along its border, and somewhat mottled; lungs almost completely hepatized; bronchi filled with white froth; hyperæmia of nearly all the lymphatic glands.

These lesions can leave no doubt of the nature of the disease produced by the inoculation.

January 23.—No. 7 was killed, and presented equally plain lesions of swine plague.

January 31.—No. 1 was killed, and found to have lesions much less satisfactory than either of the others.*

The remaining animals were allowed to recover.

Conclusions.—There can be little doubt from the period of incubation and lesions, especially with Nos. 4 and 7, that the disease produced was a mild form of swine plague. We must conclude, therefore, that chloride of zinc in solutions of one-fifth per cent. and weaker, even when mixed with a small quantity of virus in liquid form for half an hour before inoculating does not destroy the disease-producing properties of this virus, and is, consequently, in no sense a disinfectant in solutions of such strengths.

SECOND SERIES OF EXPERIMENTS.—EFFECT OF PUTREFACTION ON VIRUS.

Everything pertaining to the destruction of the virus of contagious diseases by natural agencies is of great interest, since from such facts we are enabled to judge as to the time infected premises are unsafe, and also as to the state in which the virus is preserved, as seems to be the case for considerable periods of time even when exposed to the ordinary atmospheric changes. A number of experiments bearing on this point were, therefore, made as follows:

Experiment No. 8.—One pig was inoculated March 31, 1880, by two lancet punctures in the ear, in each of which was placed a single drop of the peritoneal effusion from the pig killed at Pickens, S. C., December 29, 1879, or 93 days before. This had been preserved in a loosely-corked bottle in a warm room, and had an exceedingly unpleasant odor. It produced no effect. May 3, this pig was reinoculated with the same liquid, now preserved 126 days. No effect, either local or general, followed the inoculation. Animal preserved for several months.

* Temperature record and fuller particulars are given in appendix to this report.

Experiment No. 9.—One pig was inoculated April 12, 1880, with pleural effusion from pig No. 7, killed January 23. This had been preserved in a hermetically-sealed capillary tube, but was considerably decomposed. It is to be remarked here that hermetically sealing virus in capillary tubes does not prevent its decomposition unless unusual precautions are taken to prevent the germs of bacteria from gaining access to it, either before or during the process of filling and sealing. Three lancet punctures were made in the ear and one in thigh, in each of which a drop was placed by means of the grooved lancet. Not the least effect either local or general followed.

Experiment No. 10.—April 6, 1880, Dr. Detmers mailed to me some pulmonal exudation of a pig that had died that morning. It was received April 12. Two quills had been filled with the liquid, and the ends closed with wax. It had a dark purple color, a plain odor of putrefaction and swarmed with *Bacterium termo*, but besides this organism there were many *Bacillus* rods about $\frac{1}{35000}$ of an inch in diameter, and of various lengths, and spherical and oval granules of a similar diameter, both single and in chains. Two hogs were at once inoculated by means of the grooved lancet, punctures being made both in the thigh and ear, and a drop inserted under the skin at each point. The animals were carefully watched for a month without observing the least symptom of disease.

Experiment No. 11.—May 4, Dr. Detmers mailed me cotton wool which had been previously saturated with pleural effusion and partly dried. It was received May 10, still moist and with a slight odor of decomposition. Two pigs were immediately inoculated, by forcing small pellets of this cotton under the skin with a lancet. The pellets were selected from different parts of the mass, some being from the driest parts while others were selected because still moist. One pig had six of these pellets inserted beneath the skin of the inside of the thighs; the other had two pellets in the ear, two at inside of fore legs, and one under abdomen. No sign of disease within the next six weeks.

Experiment No. 12.—The cotton remaining from above experiment was placed in a beaker and moistened with a weak solution of salt (three-fourths per cent.), and allowed to stand four hours, when the liquid was separated by pressure. This was of a reddish color, had a slightly unpleasant odor, and contained vast numbers of bacteria, among which could be plainly distinguished *Bacterium termo* and *Bacilli*, as in Experiment No. 10, with many globular elements singly and in both clusters and chains. One pig was inoculated by hypodermic injection of three cubic centimeters of this liquid at the inside of thigh. Remained in the best of health for the next six weeks.

Experiment No. 13.—June 3, I received from the same gentleman an hermetically-sealed glass tube containing virus in a liquid form. It had been on the way eight days, and was in an advanced stage of decomposition. One pig was inoculated by inserting three or four drops in a number of punctures with the lancet. No symptoms of disease could ever be detected, though the animal was preserved for two months.

Conclusion.—Putrefaction entirely destroys the virus of swine plague, and this may occur within six days in ordinary spring weather.

THIRD SERIES OF EXPERIMENTS.—EFFECT OF DRYING THE VIRUS.

Experiment No. 14.—Four pigs were inoculated May 3, with virus which had adhered to outside of capillary tubes when these were filled December 29. This, being in an extremely thin layer, dried rapidly and re-

mained in a thoroughly dried condition. It was scraped off, slightly moistened with three-fourths per cent. salt solution, and inserted under the skin of ear and thigh with lancet. The pigs remained in good health for months afterwards.

Experiments No. 15.—One pig was inoculated May 5, 1880, with dried lung and intestine from pig killed in South Carolina, December 29. Small pieces of these organs had been thoroughly dried in the sun and preserved in a dry room; six small particles were pared from different parts and inserted hypodermically. No effect whatever was produced.

Experiment No. 16.—A single pig was inoculated June 3, by inserting a section of quill and three small pellets of cotton beneath the skin; both quill and cotton had been dipped into perfectly fresh virus, by Dr. Detmers, nine days before, and carefully dried.

June 15.—This pig has an eruption of pustules, one-fourth to three-fourths of an inch in diameter, under the abdomen and on inner side of legs. Some of the elevations have a small opening at the summit, from which pus escapes. Appetite good; temperature 103½° F.

June 22.—The animal killed by bleeding. There has been little change in appearance from that noted seven days ago. The elevations still exist, but are healing and few are discharging.

Post-mortem examination.—The peritoneal cavity contains about one-half pint of transparent, colorless liquid; the pleura and pericardium each contain one gill of a fluid of similar appearance. The intestines adhere quite firmly by newly-formed tissue. The lungs have many small indurated points throughout, probably the result of a former mild attack of the disease which this animal had in January. No other lesions were to be observed, except those plainly associated with the parasitic worms so common in this section, viz.: *Echinorynchus gigas*, *Stephanurus dentatus* and *Strongylus elongatus*.

Experiment No. 17.—The virus for this was obtained in Guilford county, North Carolina, from a hog killed the 1st of June. The outbreak of the disease in this county had extended over a section four or five miles square—a very large proportion of the hogs dying. There was effusion into the peritoneal and pleural cavities and also into the pericardium of the animal killed. The left lung was almost entirely hepatized. A small quantity of cotton wool was dipped into the pleural effusion and thoroughly dried in the air; this did not occupy one-half hour, and, consequently, there was no time for putrefaction. One pig was inoculated June 3 by forcing pellets of this cotton wool under the skin with a lancet. No effect whatever resulted.

A pig inoculated for comparison with pleural effusion preserved in a tube had dull appearance, cough, eruption of pustules and elevated temperature (104¼° F.) the twelfth day, but soon recovered.

Experiment No. 18.—Two pigs were inoculated July 12, 1880, by inserting two small pellets of cotton under the skin on inside of thigh. This cotton was prepared July 2, by moistening in the liquid which exuded from a section through the hepatized portion of a lung taken from a pig killed near Charlotte. It was immediately dried by spreading in a thin layer and exposing to a current of air. No effect whatever followed the inoculation.

In addition to these experiments, I sent virus to Professor James Law about the 1st of October, 1878. It was the liquid obtained by section of the hepatized lung of a pig in the first stages of the disease; quills were dipped into this and dried in the air. Professor Law succeeded in producing the disease with this virus five days later.

These experiments indicate that the virus thoroughly dried and pre-

served in this condition loses its activity in a few days. Professor Axe has published experiments which show that the dried virus may remain active for twenty-six days, and Professor Law has produced the disease with dried virus six days old. It is possible that in the moist climate of England the virus may retain its activity much longer than in America. In the above experiments the disease was induced in one case with virus nine days after drying, but it failed with one animal two days after drying, with two after ten days, and with five animals one hundred and twenty-five days after drying. It has been recently ascertained, also, that complete desiccation destroys the virus of glanders in fifteen days.*

These facts lead us to believe that the well-known disinfecting effects of free ventilation are due to the thorough desiccation of the virus; and they make it plain that this, the cheapest of all means of disinfection, should never be neglected in dealing with this class of diseases.

FOURTH SERIES OF EXPERIMENTS.—INOCULATIONS WITH CULTIVATED VIRUS.

Experiment No. 19.—Virus which had been preserved ten weeks in a capillary tube hermetically sealed was cultivated for eight generations in urine. The method of cultivation was to fill a previously-heated test-tube half full of fresh urine, to this was added a few drops of the preserved liquid (peritoneal effusion), and the tube covered with sheet caoutchouc well tied down. The tube was kept in an incubator at 95° to 100° F., and in about twenty-four hours would become cloudy by multiplication of microscopic organisms, when another tube would be prepared in the same manner and inoculated from it.

April 7 the eighth generation was obtained and a single pig inoculated by hypodermic injection of twenty minims.

May 3 this animal had a plain eruption of papules with reddening of skin under the belly and on inner side of legs. The appetite was good and temperature but $101\frac{3}{4}$° F. The eruption and discoloration disappeared in a few days.

Experiment No. 20.—In a certain number of test-tubes, containing infusion of beef, which were placed in the incubator without addition of any kind, and merely for comparison with those to which virus had been added, spherical granules appeared which in size and appearance resembled the micrococci that I had observed in cultivations of virus. To test their pathogenic properties two pigs were inoculated, April 1, by hypodermic injection of fifteen drops each, of the infusion containing them. May 3 they presented considerable discoloration of skin and slight eruption very similar to that noted in the preceding experiment. There was at no time loss of appetite or any other symptom of illness.

Conclusions.—Though in the two experiments of this series the symptoms of swine plague were as plain as some investigators have considered necessary to determine the success of an experiment, I should certainly hesitate to conclude that this disease had really been induced in either case. A discoloration of the skin, a slight eruption, a little coughing or sneezing are symptoms which are frequently met with when swine plague cannot be suspicioned; and in matters of such great importance, which indeed influence our whole theory of the disease, it seems to me something more definite should be required. There can only be certainty when real sickness, with loss of appetite and the characteristic internal lesions, are produced.

* Comptes Rendus, xci (1880), p. 476.

MICROSCOPIC INVESTIGATIONS IN REGARD TO THE NATURE OF THE VIRUS.

The great interest that is at present attached to the microscopic characters of the virus of contagious diseases as a class, and particularly to that of swine plague since the publication of the investigations of Doctors Klein and Detmers, led me to devote as much time and care to this method of research as could possibly be bestowed upon it without interfering with other duties. The lenses used were generally the one-tenth and one-fifteenth immersion of Tolles, combined with a 1½-inch eye-piece and giving 600 and 1,000 diameters respectively. A ¾-inch eye-piece which doubled these powers was occasionally used, but what was gained in amplification was lost in definition, so that as a rule the lower-power eye-piece gave the most satisfactory results.

As it is impossible to give a detailed account of all the observations made, since a dozen or more preparations were often examined in a single day, in each of which would be several hundred microscopic fields, I select those which combine the most important features. I have had no preconceived theory to bolster up by reporting such observations as supported it and rejecting those opposed; but, on the contrary, I have endeavored to present an unbiased *résumé* of what I have seen without regard to its influence on this or that particular theory.

While the pigs of the first series of experiments were sick, a considerable number of preparations of blood were made and examined. The blood was generally taken from the ear; the slides and cover glasses were always cleaned with great care and often passed through the flame of an alcohol lamp.

January 15 the blood of the pig in Experiment No. 4 was found to contain a vastly increased number of white globules (leucocytes), and besides these there were many granules varying in size from a mere point, as seen when magnified 1,000 diameters, to the size of the blood globules. They were apparently structureless, of irregular form, and motionless. They were, as near as could be ascertained, identical with granules frequently found in normal blood, and doubtless consist of fibrin.*

The blood of No. 1 was examined the next day (January 16), and was found to contain the same increase of the irregularly-formed granules, but without notable increase of leucocytes. Fig. 1 is a drawing made with a camera lucida of a part of a field in one of these preparations.

In the blood of the animal killed January 17 there were very many granules of a different character; they were of uniform size, spherical, $\frac{1}{30000}$th of an inch, or less, in diameter, and without motion. When perfectly fresh there were no *Bacilli* or other bacterial filaments to be found; but in a preparation kept a few days for further examination, a certain number of these appeared. Fig. 2 shows some of the forms which were thus developed; it also shows the multiplication of some of the *Bacillus* filaments by a process which has been overlooked by many investigators, viz: The formation of spherical granules from filaments by fission. Similar observations have also been made by Dr. T. R. Lewis.† The few filaments shown were the only ones in the preparation, and the short rods were by no means numerous. The spherical granules, however, existed in large number, as seen in Fig. 3.

* Ranvier, Traité Technique d'Histologie, p. 217.

† The Microphytes which have been found in the Blood and their Relation to Disease. Quart. Jour. Mic. Science, 1879, p. 393.

As soon as the pig killed January 31 was dead, I prepared several slides with the greatest care, and, after placing upon them some of the contents of the smaller bronchi, cemented down the cover glass with Canada balsam. One of these preparations still (October 15) presents the same appearance as when first examined. It contains great numbers of leucocytes of various sizes; some of these are breaking up into bright granules of similar appearance, but differing widely as to size, and which evidently consist of fat (Fig. 4, *a*.); but others are filled with uniform, apparently spherical, granules about $\frac{1}{30000}$th of an inch in diameter. In many cases the homogeneous connecting substance seems to have disappeared and the position of the leucocyte is only marked by a cluster of granules still near together and exactly resembling, in size, shape, form of cluster and general appearance, those in the still intact cells. In other cases the retrogression has gone still farther, and the granules are more or less scattered and now would be considered as micrococci (Fig. 4, *e*, *f*). Besides the globules and granules mentioned there was only a small number of cells from the mucous membrane lining the air-passages, and some globules varying in size, the nature of which could not be determined, but which were thought to be a form of oil. Though carefully examined with the one-fifteenth objective as soon as prepared, and several times since, I have never been able to find either a cylindrical *Bacillus* spore, a *Bacillus* filament, or anything resembling bacteria, with the exception of the granules already noted, which many would call micrococci.

Granules of similar size, and staining deeply with carmine, were observed in the inflammatory new formation on surface of kidney of the pig killed January 23 (Experiment No. 7).

At the time the Guilford county pig was slaughtered (see Experiment No. 17 above), four capillary vacuum tubes were filled with virus, as follows: The finely-drawn-out end of a tube was forced through the walls of the jugular vein, the extremity broken within the vessel, and the tube allowed to fill completely, when it was withdrawn and immediately sealed with the blow-pipe. Three other tubes were filled with pleural and peritoneal effusion, care being observed to plunge them deeply into the liquid before breaking the point, in order to avoid introduction of germs which might have fallen on the surface of the liquid.

When examined with the microscope two days later (June 3), these liquids were perfectly fresh—there was no escape of gas on breaking the tubes, no unpleasant odor, and the liquor sanguinis of the blood and the transparent effusions were free from any cloudiness, with the exception of one tube that had filled imperfectly. Putrefaction had, therefore, not commenced, and two days had been allowed for the development of such germs or organisms as were peculiar to the virus; if, then, the disease is caused by *Bacilli* or their germs, the developed filaments should be present in these tubes in much larger number than other bacteria forms.

Results of microscopic examination.—Tube No. 1, pleural effusion, contained many very small spherical granules (monococci); many couples of these (diplococci); a few chains of three to ten elements similar in appearance to the single granules (streptococci); a few chains and couples of oval elements $\frac{1}{10000}$th of an inch in short diameter by $\frac{1}{25000}$th of an inch in long diameter. A few *Bacilli* were present mostly as single rods, though one chain of these made up of six rods was seen, each of which was $\frac{1}{2000}$th of an inch in length; but not more than three or four of these filaments could be found in a preparation, and the majority of the fields contained none, though swarming with the mono and diplococci. Fi-

nally, many gliacoccus masses were to be seen made up of the spherical granules, the size of these clusters being sometimes twice the diameter of the red globules.

Tube No. 2; pleural effusion: This tube did not fill entirely, and had commenced to decompose. It contained many monococci and diplococci; a few *Bacterium termo* and some oval granules having the appearance of spores, but no rods.

Tube No. 3; peritoneal effusion: Many granules single and in couples as above, a few in chains; no *Bacilli*.

Tube No. 4; blood: This being the only tube that could be filled with absolute certainty of excluding atmospheric germs, much more weight should be placed upon the results of its examination than upon either of the others. It contained a considerable number of spherical granules, similar to those found in the other tubes, and something less than $\frac{1}{30000}$th of an inch in diameter; also some white particles $\frac{1}{20000}$th to $\frac{1}{12000}$th of an inch in diameter, irregularly round or elliptical—probably fibrin. No *Bacilli* nor cylindrical granules resembling their spores.

In the account of Experiment No. 16, the virus for which was obtained from Dr. Detmers, mention is made of an eruption of pustules occurring on the thinner parts of the skin of the inoculated animal. The pus from one of those was examined under the one-fifteenth objective, June 18. It contained, besides the pus globules, spherical granules about $\frac{1}{30000}$th of an inch in diameter, existing both singly and in couples, very uniform in size and appearance, and having a very lively molecular or Brownian motion. No other figured elements could be discovered.

When this animal was killed (June 22), capillary tubes were filled with the peritoneal effusion, and also with blood, by breaking the fine extremity within a vein. They were then immediately sealed and laid aside till convenient to examine. The effusion preserved in this manner and examined within two hours seemed to contain no definite figured elements. After two days a few spherical granules, similar to those found in the pus, were observed.

The blood, preserved two days, contained a considerable number of spherical granules of identical appearance. But here was noticed for the first time a phenomenon which seemed to merit particular attention. The granules existed for the most part near the clusters of leucocytes—some were upon or even within these; while surrounding the leucocytes and often embracing the granules could be made out a finely granular matter, which was evidently the protoplasm freed by partial disintegration of the corpuscle. Many of the leucocytes, indeed, had become so indistinct that it was difficult to make out their outline, and in other cases there was only the finely granular matter containing the larger granules, the corpuscles having entirely disappeared. Fig. 5 is a drawing made from a preparation of this blood.

Taking into consideration the gradations of disintegration observed, the presence of the granules near the clusters of leucocytes and even within them, and it seemed very probable that these granules were originally a constituent of the leucocytes, and that they escaped from these as a result of vital modifications occurring either before or after the death of the animal.

Such granules might, however, consist entirely of fat, and therefore be lifeless and incapable of reproduction; or they might be protoplasmic granules endowed with life, and capable of indefinite multiplication. Their uniform size indicates that they are not oil globules, and the fact that they are not dissolved by ether corroborates this view; but the

ether test as generally applied by microscopists is not entirely reliable with particles of such small dimensions, and it is probable that their behavior towards the different staining agents will be found a more satisfactory method of determining their nature. My own investigations in this direction have been too few to give any safe basis for a decision; but the fact that granules that could not be distinguished from these in appearance multiplied enormously in some of my tubes of blood led me to consider these as living and capable of reproducing themselves indefinitely under favorable conditions.

No *Bacilli* or other bacterial filaments could be found either in the pus, in the peritoneal effusion, or in the blood; nor did any develop in these liquids while preserved from contact with the air.

While at Charlotte, July 2, 1880, Mr. Wadsworth informed me that hogs were dying of cholera on his farm near the city, and kindly gave me permission to kill any animals that I might wish to examine. I found about fifty hogs running in a large wood lot through which flowed a small stream of water. A walk through the lot disclosed three dead animals already in an advanced stage of decomposition. A number of others were plainly sick, some of which had abscesses one-half inch to three inches in diameter scattered over the surface of the body. The one showing most marked symptoms was selected and slaughtered. This animal had a large abscess in the flank fully six inches in diameter with very thick fibrous walls. Similar though smaller ones existed beneath the thorax. The abdomen was distended with a colorless, transparent peritoneal effusion, the intestines adhered closely from the formation of false membranes, and in the duodenum were many small erosions. The spleen was enlarged and the lymphatic glands engorged with blood. The pericardium contained one-half ounce of clear liquid; the lungs were mottled with lobular pneumonia, but there was no pleural effusion. In the intestine were found in large number the parasitic worms known as *Echinorynchus gigas* and *Sclerostoma dentatum;* the *Stephanurus dentatus* abounded in the fat about the kidneys, and the *Strongylus elongatus* existed in considerable numbers in the bronchi.

Two vacuum tubes were filled with blood by forcing the finely-drawn-out end, previously passed through the flame of an alcohol lamp, into a small vein, then breaking across the walls of the vessel and allowing them to fill. They were then immediately withdrawn and sealed. Two other tubes were filled with peritoneal effusion by plunging deeply beneath the surface, to avoid germs from the atmosphere, before breaking the points. One tube containing blood and one with peritoneal effusion were sent to Professor Law, with a request that he make a careful microscopical examination of their contents as soon as they were opened. The remaining two were kept for my own examination.

Just here it seems advisable to call attention to the capillary vacuum tubes made and used by me for these investigations. A piece of glass tubing, with an internal diameter of about one-eighth of an inch and two inches in length, is drawn out to a fine tube about one-twentieth of an inch in diameter at each extremity. After cooling, a few drops of water are forced into the body of the tube, and boiled in the flame of the lamp till entirely vaporized; the tube is not yet withdrawn, however, but is held in the flame till nearly red, when the two extremities are quickly sealed. Made in this way, the tube when sealed contains superheated steam, and the temperature is so high that no germs can possibly withstand it; on cooling, the steam condenses and forms a scarcely visible globule of pure distilled water, leaving the cavity almost a perfect vacuum. If, now, we pass such a tube through the flame of an

alcohol lamp to destroy any germs adhering to its surface, then force one of the ends through the wall of a freshly-laid-bare vein, break the extremity within the vein by pressure across its walls, allowing the tube to fill with blood never for an instant exposed to the air, and then immediately seal the broken end in the flame of a lamp, we may keep such a tube for an indefinite time for the germs contained in the blood to multiply and develop, and still feel reasonably certain that what we see, when examining its contents, was in the blood while circulating in the veins. But if we allow the blood to come into contact with the air for a single second, loaded as the atmosphere is with the germs of every variety of bacteria, there is no longer any safety in concluding that the *Bacilli* and other septic organisms, which develop after a few hours or days, really existed in the blood during the life of the animal. Consequently we cannot lay great stress upon the organisms found in the tubes containing the effusion, because this necessarily comes in contact with the air when the cavity containing it is opened, but it was believed that most of the atmospheric germs would float on the surface, and that by plunging the extremity of the tube to be broken well into the liquid most of these would be avoided.

With this in advance as to the method employed, I will now give the results of the examination of the contents of the tubes July 12, or ten days after filling.

The clot formed in the tube containing blood was partly dissolved, and, on breaking, a small quantity of gas escaped. The liquid swarmed with micrococci, some existing as single spherical granules (monococci), others united by twos or threes, many in long chains (streptococci), while still others were in *zooglœa* masses (gliacocci). In whatever form they existed they were of uniform size and spherical, and had the Brownian movement in a very marked degree. Fig. 6 shows a part of a field in one of these preparations. There were no *Bacilli* whatever to be found, nor indeed could any other organism be discovered with the exception of a single oval fungus spore $\frac{1}{12000}$ by $\frac{1}{8000}$th of an inch in size, which possibly gained entrance after the blood was placed on the slide and before it could be covered with the thin glass.

The tube that contained the peritoneal effusion showed from its appearance that decomposition had advanced to a considerable extent; on breaking there was a marked escape of gas with a very offensive odor. The same micrococcus forms as were found in the blood existed in vast number, and in addition there were *Bacterium termo*, some members of a broad *Bacillus* $\frac{1}{20000}$th of an inch in diameter, containing oval spores, and also a fine *Bacillus* $\frac{1}{35000}$th of an inch in diameter.

Professor Law wrote me that he examined the tubes sent to him on the 8th of July, or four days earlier than I was able to examine mine. For this he used a Hartnack No. 10 immersion objective, which is of about the same power as the lens used by me. In the blood he found no *Bacilli*, and no active organisms of any kind; besides the blood globules there were a very few crystals and isolated granules.

In the peritoneal effusion, on slides not passed through the flame of a lamp, he found very many *Bacillus* forms, but on flamed slides there was an organism somewhat like *Bacterium termo* and minute granules, with a single non-motile filament. With this virus he succeeded in producing a case of swine plague with characteristic intestinal lesions.

I inoculated two pigs from each of the tubes which I retained, as soon as they were opened and their contents examined. Those inoculated with the peritoneal effusion showed no signs of ill health, but those inoculated with the blood both sickened. July 19, or seven days after

inoculation, they had diminished appetite, a dull appearance, with a temperature of 103° and 104¾° F., respectively. July 21, no appetite, dull, slightly staggering gait; temperature 103½° and 105° F. The next day they had diarrhea, which was followed in a few days by constipation.

August 6 there was signs of improvement, when one of the animals was killed. The whole intestinal tract was found reddened, and the mucous surface of the large intestines was studded with small ulcerations, the cæcum being most involved. The liver was mottled, and the lungs extensively hepatized. The blood, before and after death, contained the spherical granules; in the latter case a few chains and zooglœa masses were observed. In the blood drawn from the ear and in blood caught in a bottle at the time of slaughter, a number of oval granules $\frac{1}{30000}$th of an inch in short diameter or smaller were observed—they resembled *Bacillus* spores, but as no precautions to prevent access of air had been taken they probably gained entrance after the blood was drawn; indeed, I have frequently seen such granules in blood from my own finger placed on a slide and immediately examined.

What I wish to insist upon, by way of conclusions from this series of observations, is as follows:

1st. The pig killed at Charlotte July 2, 1880, was affected with swine plague, as is proved not only by its lesions but by inoculations made by Professor Law and myself.

2d. The blood of this animal had not developed *Bacilli*, even when preserved for six and ten days after the slaughter.

3d. The microscope with a power of one thousand diameters revealed in the blood thus preserved vast numbers of *spherical* granules, not all isolated, as is seen in the case of spore formation by the disintegration of *Bacillus* rods, but united in chains and clusters of every conceivable form, as occurs with micrococci in active multiplication; and in this blood could be discovered neither *Bacillus* rods nor oval or cylindrical spores of these.

4th. This blood was still virulent, as was shown by inoculation on two animals, both of which sickened in seven days, with the characteristic symptoms of swine plague, and one of which, when slaughtered, presented typical lesions of this disease.

CULTIVATION OF THE VIRUS.

1. *Cultivation on slides.*—March 10, five slides were prepared by putting a drop of fresh aqueous humor of a rabbit on the thin cover; this was then inoculated with the smallest possible particle of coagulum taken from a capillary tube filled at Pickens, S. C., December 29, 1879, with effused liquid found in the peritoneal cavity of a pig suffering from swine plague. The cover thus prepared was then inverted over a Brunswick black cell painted on an ordinary glass slide. As a moist chamber, in which to keep these free from evaporation, an ordinary soup-plate was half filled with sand previously dried at a high temperature and now moistened; across this wet sand glass tubes were laid to keep the slides from coming in contact with it, and the slides placed thereon, when the whole was covered with a square of glass to retain the moisture. The whole was kept in an incubator at 95° to 100° F.

Five hours later the drops of aqueous humor were swarming with single granules and aggregations of these—nearly all with molecular motion.

Twenty-four hours after inoculation the preparations were filled with the aggregations of granules; no movement in any, and but few single granules to be seen. No *Bacilli*.

A slide prepared in the same way but inoculated from another tube was examined immediately after inoculation and the inoculating particle found to be filled with the mycelium and spores of a fungus. As other preparations were entirely free from such organisms the presence of this was not considered as having any connection with the subject under investigation. The granules were also present in vast numbers singly and in clusters.

March 18. No *Bacilli* have developed in any of these preparations; they have been examined carefully every day. In only one of them is there any activity; this swarms with single granules and small aggregations as in a freshly-inoculated cell. Most of the clusters are of considerable size, held together by a gelatinous matrix. A very few short rods $\frac{1}{12000}$th of an inch in length have been found. Nearly the whole space to be seen is occupied by the granules.

Final examination, March 25. No material change since the last examination. All activity has ceased; the granules have not developed into filaments.

March 12, four slides were prepared, using urine as a cultivating medium, and inverting the thin cover directly on the slide to favor the access of air. In other respects the cultivation did not differ from the preceding one.

March 13 and 14, the micrococci alone are seen in various-sized clusters as before.

March 15, filaments have grown from a few of the clusters (Fig. 8), but whether the granules of such clusters were identical with the others could not be ascertained; certainly the vast majority of clusters showed no sign of producing filaments. A considerable number of fungus cells exist in some of the preparations, and mycelium from these has grown luxuriantly. In these preparations the granules were first observed in the form of a chain, made up at times of thirty or more elements.

March 23, all of the slides are crowded with the micrococci; on three of the slides are to be seen a considerable number of fine rods $\frac{1}{50000}$th of an inch or less in diameter, and $\frac{1}{2000}$th of an inch in length. In two a few fungus spores and mycelium.

2. *Cultivation in test-tubes.*—March 9, six test-tubes were partly filled with infusion of beef and sterilized by heat. They were closed by rubber corks, through which passed a glass tube packed with cotton wool for ventilation. They were inoculated with one drop each from a capillary tube containing virus. March 16, but two of the tubes were found to contain a pure growth of the granules, the others contained considerable numbers of a *Bacillus*, resembling *Bacillus subtilis*, another with a much finer filament, and also *Bacterium termo*.

Six tubes of the same infusion were placed in the incubator at the same time to determine what organisms would develop spontaneously. In all of these could be found the broad and the fine rods already mentioned, and in two were observed clusters of granules with exactly the same appearance as those which developed from the virus. Inoculations made from these were followed with a slight eruption and reddening of the skin, but without other signs of sickness.

Effect of disinfectants on this micrococcus.—So constantly were the granules which I have just described and figured found in the blood and liquid inflammatory products of the sick pigs which I had the opportunity to examine, that it was deemed advisable to test its powers of resistance to various agents supposed to have disinfecting properties. It was hoped that by comparing the effects of such agents upon this organism, as shown by direct microscopical observation, with the effect

of the same agents on the activity of the virus, as proved by inoculation, a safer conclusion could be reached as to whether this organism really constituted the active principle of the virus. For some unknown reason it has been impossible for me to obtain a form of swine-plague sufficiently virulent to allow me to carry out the second part of this programme. I have several times succeeded in producing by inoculation very severe cases, though no fatal ones; but when a second inoculation was made with blood or inflammatory effusions of such sick animals, even when two or three cubic centimeters were injected hypodermically, the disease produced would be so mild as to be scarcely noticeable. Conclusions from such experiments are evidently so unsafe that I finally relinquished the idea of accomplishing anything in this direction until more favorable conditions should prevail.

The experiments were made with the micrococcus by adding a drop or two of the liquid in which it existed to a test-tube half filled with fresh urine, which seems to be a very favorable medium for its development; a measured quantity of the disinfectant was then added and the tube covered with sheet caoutchouc closely tied on. The tubes were kept in an incubator at a temperature of 90° to 100° F. for a few days, when a microscopical examination determined if there had been any multiplication of the organism in question. It was thus determined that it would multiply in a solution containing 1 per cent. of carbolic acid, but not in one containing 2 per cent.; and that a 2 per cent. solution even destroyed the life of the granules. To prevent its multiplication required 2 per cent. of borax, 1 per cent. of benzoic acid, one-third per cent. of either sulphate of quinine or iodine, one-fifth per cent. of salicylic acid, and one-tenth per cent. of chloride of zinc. Quassia, even in a 4 per cent. solution of the extract, had no effect upon it. It was destroyed by a heat of 150° F. for fifteen minutes, but resisted 140° for the same length of time.

Of course the fact that an organism will not develop in a 1 per cent. solution of carbolic acid is no proof that it is destroyed by a solution of this strength; the solution may be simply unsuitable for the development of the germs, these remaining in a dormant condition. The destructive effect of a disinfectant may be learned by slightly varying the experiment; thus, we place two drops of the virus in a watch-glass and add to it two drops of a 2 per cent. solution of the disinfectant, making the mixture equal to a 1 per cent. solution. After mixing and leaving in contact for an hour or two the whole may be added to a test-tube containing a solution favorable for the development of the organism. Its multiplication is then the criterion by which to judge of the effect of the disinfectant. In all such cases the greatest care must be exercised to prevent the addition of atmospheric germs. The tubes, &c., must be boiled for several hours or heated nearly to redness before using. Even then, it is generally impossible, without more complicated apparatus, to prevent the introduction of the septic bacteria; but the germs used for inoculation are in so much the greater number that as a rule they obtain the advantage in the struggle for existence.

It occurred to me that there might be septic organisms having the same appearance as the one I was cultivating, and that the introduction of such might vitiate the experiments. To decide this point a large number of tubes containing nutritive solutions exposed for several days to the contact of the air were examined to determine the forms then present in the atmosphere. In two instances an organism similar to the one I was cultivating thus appeared spontaneously, and, when inoculated, in one case produced a slight eruption, as already reported.

There were three or four kinds of *Bacilli* that were present in nearly every putrefying liquid. One of these was less than the $\frac{1}{35000}$th of an inch in diameter, another was about $\frac{1}{30000}$th of an inch, and the largest about $\frac{1}{20000}$th. These, with *Helobacteria* and the *Bacterium termo*, were the forms most commonly met with.

A more extended consideration of the theory of the swine-plague contagium will be found in Part III of this report.

PART II.—INVESTIGATIONS OF FOWL CHOLERA.

It has long been evident that an exceedingly fatal contagious disease of fowls has become distributed over the whole country, and that it causes enormous annual losses. This disease is popularly known as chicken cholera.

A similar if not identical malady causes extensive losses among the poultry of Europe; in France this is also called cholera (*choléra des poules*). Some investigations of its nature were made some years ago by M. Reynal, and quite recently it has been more carefully studied by MM. Toussaint and Pasteur.

As long ago as December, 1879, I commenced investigating the epizootic diseases from which fowls were dying. At first I was unfortunate in fixing my attention on enzootics evidently due to local causes. Of three separate outbreaks thus investigated not one proved to be the result of inoculable disease; and it was not until July, 1880, that I succeeded in obtaining virus of what is undoubtedly the true chicken cholera, by which so many fowls are swept away. This disease existed at the house Mr. R. M. Miller, of Charlotte, who informed me that he had lost on his farm nearly 500 chickens from it during the year. At the time of my visit, his Plymouth Rocks, which he kept at his house in the city, were suffering. I at once inoculated two spring chickens with excrement from living sick birds and with blood, bile, and pieces of liver from those recently dead. After five days they were still perfectly well. The French investigators having determined that death occurs within two or three days after inoculation, and most frequently within twenty-four hours, I had nearly concluded that our chicken cholera was not an inoculable disease; but in order to be absolutely certain I requested Mr. Miller to allow me to bring a hen in the first stages of the disease to my own farm, more than one hundred miles away, and on which no contagious disease of fowls had ever existed. This he kindly consented to, and it was with virus obtained from this bird that my experiments were made.

The disease proved to be inoculable, and the period of incubation so much longer than with the affection as it exists in France as to explain why the chickens inoculated at Charlotte did not sicken. I have not learned if they contracted the malady later, as I was unable to bring them with me; but this matters little, as I have now the most complete evidence of the transmissibility of the disease.

For convenience of examination and to avoid repetitions, the inoculation experiments will be related first, then the symptoms and *post-mortem* appearances, and, finally, my microscopic investigations.

EXPERIMENTAL STUDY OF THE DISEASE.—1. IS IT COMMUNICABLE?

Experiment No. 1, *July* 10.—The Charlotte hen was placed in an inclosure rather less than 6 feet square, with three other hens, and, to make infection more certain, a large double-sheet newspaper that had

been in the bottom of the basket used for transporting the hen, and which was saturated with the excretions, was thrown into the inclosure.

July 13.—The Charlotte hen found dead this morning. Two of the hens inoculated by placing under the skin and into the muscular masses beneath the wing by means of a grooved lancet, bowel contents, blood, liquid pressed from liver, and even small particles of this organ, three or four punctures being made in each case. The liver and parts of muscle were then cut into small pieces and fed to these hens. It was believed that this would decide the question of communicability.

July 17.—One of the inoculated hens appears less lively than usual, and the comb is losing its bright healthy hue.

July 18.—This hen has diarrhea, and is plainly sick.

July 19.—She sits sleeping, and is only startled with difficulty. Temperature at 7 a. m., 104° F. Died at 7.40 a. m., or six days after inoculation. The second hen has diarrhea, and a temperature of 108¾° F. The third hen not inoculated but kept in the same inclosure is apparently well. Temperature 107° F.

July 22.—The second hen inoculated is very sick; does not notice what is occurring about her; sleeps continually, and is only roused by a touch. She is very weak, and has great difficulty in walking. Temperature 108½° F.

July 23.—This hen is dead, ten days after inoculation. The remaining hen still well.

The disease is, then, certainly communicable; but in what way has this infection occurred? Several different substances have been used for inoculation; the birds affected were even fed portions of the liver and muscles of a dead hen; they cohabited with her. Evidently the next point to be determined was as to whether the malady had been contracted from the inoculations, through the food, or by inspiring infected air. It is true the hen not inoculated remained well, but the period of incubation may be longer with her, or she may be insusceptible. Before commencing a series of investigations, it is necessary to know what parts of the body or which of its liquids contain the virus and are to be depended upon as a means of inoculation.

2.—THE LIQUIDS OR ORGANS CONTAINING THE VIRUS.

Experiment No. 2, *July* 19.—A hen inoculated by two lancet punctures with fluid pressed from liver.

July 23.—Diarrhea and dullness.

July 24.—Very sick; temperature at 7 a. m., 109½°. Dies at 3 p. m.

Experiment No. 3, *July* 23.—One hen inoculated by two punctures with excrement from the cloaca of a hen just dead.

This bird was kept under observation for six weeks but no effect followed the inoculation. She was probably insusceptible.

Experiment No. 4, *July* 23.—One hen inoculated by two lancet punctures with blood from the heart of a hen just dead.

July 29.—Diarrhea.

August 7.—Very sick.

August 8.—Died during the night.

In all the inoculations noticed in this report the lancet was disinfected by heating to redness, and every precaution taken to prevent mistaken conclusions.

Experiments Nos. 2 and 4 prove, then, that the liquid pressed from the liver and the blood contain the virus. Experiment No. 3 resulted

negatively; it does not prove that the excrement is free from the virus, for the hen may have been insusceptible to the disease. At the time of writing I have not been able to repeat the experiment.

3.—Effect of taking the virus with the food.

Experiment No. 5, July 23.—The hen placed with the sick one from Charlotte July 10, but not inoculated, has remained well, though four birds have now died in the same inclosure. A large Plymouth Rock cock is placed with her, and the two fed with the liver and muscles from the breast of a hen that died the preceding night. A third hen inoculated with liquid from the liver for comparison.

July 27.—Both have diarrhea; temperature of hen 109°, of cock 107° F.; temperature of hen for comparison 107¼° F.

July 28.—Hen has a temperature of 109¼° F.; comb and gills pale, cold, and bloodless. Cock has a temperature of 108½° F. The hen inoculated for comparison has also pale comb and gills; temperature 107½° F.

July 31—Hen dead.

August 2.—Cock found dead this morning.

The hen inoculated for comparison has little appearance of the disease. She was again inoculated to test her susceptibility; sickened August 7; began to improve August 13, and was well by the 20th.

Considering that the hen had been in this inclosure for thirteen days without contracting the disease, and that both she and the cock sickened in four days, I think we have here sufficient proof that the disease was contracted through the food. This is also the conclusion of the French investigators, and is confirmed by other facts in regard to the contagion.

4.—Are the germs transported by the atmosphere?

Experiment No. 6, July 29.—Two hens were placed in a coop within 4 feet of the one in which most of the deaths already reported had occurred, and in which sick fowls have been continually kept to prevent loss of virus. The coop in which the two hens were placed was occasionally moved its width to keep on fresh ground, but was never farther than 10 feet from the one in which were the sick ones. It remained thus till October 6, or sixty-nine days, both hens being still in the best of health.

In my other experiments I have had as many as fifty fowls within a few yards of sick ones, some having remained this near for one or two months, and in only one case has the disease appeared except from my inoculations.

Major Cox, of Atlanta, informed me that he had not been able to raise fowls at his place in that city for years on account of the cholera. But his neighbor, whose lot is only separated from his own by a stone-wall, was never troubled with the disease till the past year.

Here, then, appears to be good evidence that the germs of the disease are not transported through the atmosphere. In one case, however, a chicken in one of my experimental coops did take the disease spontaneously and die with it; but, more remarkable than this, two hens and one half-grown chicken of my home flock, kept at a distance of more than 200 yards from the coops of the sick ones, have contracted the disease and died. And the periods between their sickness were so long as to make it certain they did not contract the trouble from each other. One of these was just weaning a brood of chickens, and as she sickened no

longer drove them from her; as a consequence they crowded about her, perched upon her back, and even sheltered themselves beneath her wings. Only one of these chickens ever sickened, and that so long (five weeks) afterwards as to make it certain the disease was not contracted from the mother.

I have concluded, therefore, that the disease is not contracted from germs carried through the atmosphere, in the strict sense of the term, but that we owe such occasional transportation of the disease to flies or other insects which eat the blood during dissection, or which feed upon the other juices of the body, or upon the excretions. A fly, for instance, will eat sufficient blood to inoculate twenty or thirty fowls, and if captured soon after such a meal by a susceptible bird would almost certainly convey the disease, since the germs taken with the food have the same effect as when inserted under the skin with a lancet.

5.—Is the disease contracted from infected habitations?

Experiment No. 7, *October* 6.—A Plymouth Rock cokerel placed in a coop in which there have been sick fowls almost continually since July 10, the last one affected having died September 27, or nine days earlier.

October 20.—Plainly sick.

October 21.—Dead.

This, then, is a positive experiment; the bird contracted the disease after being fourteen days in the infected coop and died on the fifteenth day.

6.—Effect of putrefaction on virus.

Experiment No. 8, *July* 30.—One hen inoculated with fluid pressed from the liver, July 24, and which has a strong odor of putrefaction. This hen has remained well to the present, and has been proved insusceptible by two subsequent inoculations. The experiment is, therefore, without result.

7.—Effect of drying the virus.

Experiment No. 9, *July* 30.—A cock affected with cancer of the comb inoculated with pieces of dried liver, prepared by cutting a thin slice and drying at ordinary atmospheric temperature for seven days. No effect resulting, he was reinoculated with active virus September 4 to test his susceptibility, but he died September 8 from the effect of the cancer before any signs of cholera had appeared.

8.—Effect of diluting virus.

Experiment No. 10, *July* 31.—One hen inoculated with a mixture made by diluting one drop of fluid pressed from the liver with twenty-five drops of diluted glycerine (glycerine one part, distilled water eight parts), having about the specific gravity of blood. Two punctures were made into the muscular masses beneath the wing with the grooved lancet charged with this virus.

August 20.—Has drooped for several days, voids large quantities of excrements of a normal consistency, the urates of which are deeply colored with yellow.

August 24.—Has diarrhea; very sick.

August 27.—Much better.

August 29.—Entirely recovered.

Experiment No. 11, *July* 31.—One hen inoculated by two lancet punct-

ures with virus diluted as above with one hundred parts of glycerine mixture. No effect. Has since been inoculated and proved insusceptible.

It would appear from these experiments that diluting the virus prolongs the period of incubation and produces a disease of a milder form. The hen in experiment No. 11 may have had so mild a form of the disease that it was not noticed, and may thus have acquired her insusceptibility. It would be unsafe to reach any conclusion, however, without more experiments.

9.—THE BLOOD IN THE BODY RETAINS ITS VIRULENCE THIRTY-SIX HOURS AFTER THE DEATH OF THE BIRD.

Experiment No. 12, *August* 9.—Two chickens inoculated with liquid pressed from liver of a hen found dead yesterday morning (thirty-six hours ago) and which was not examined until to-day.

August 20.—One has diarrhea, sleeps, temperature 109° F.

August 23.—Both now very sick.

August 25.—One dead.

September 10.—The second dead.

10.—THE ALCOHOLIC EXTRACT OF BLOOD NOT VIRULENT.

Experiment No. 13, *August* 11.—Two spring chickens inoculated with alcoholic extract prepared by treating blood and fluid, pressed from liver with an equal volume of 95 per cent., alcohol, allowing it to stand thirty-six hours, and then filtering and drying the residue. No effect produced. The birds afterwards proved susceptible when inoculated with active virus.

11.—EFFECT OF SALICYLIC ACID ON VIRUS.

Experiment No. 14, *August* 25.—Virus prepared by intimately mixing with an equal volume of a 2 per cent. solution of salicylic acid containing sufficient borax to cause the acid to dissolve. The mixture, which consequently equaled a 1 per cent. solution, then allowed to stand three hours, when two chickens were inoculated by means of four lancet punctures each, two under each wing. No effect produced. The activity of the virus and susceptibility of the birds both proved by other inoculations.

12.—EFFECT OF BENZOIC ACID ON VIRUS.

Experiment No. 15, *August* 25.—Virus prepared by mixing with an equal volume of a 2 per cent. solution of benzoic acid, containing sufficient borax to cause the acid to dissolve. The mixture thus equal to a 1 per cent. solution of the acid, allowed to stand two and one-half hours, and inoculated by two lancet punctures under each wing of two chickens. No effect. The virus, before treatment with the acid, was proved active by inoculation.

Experiment No. 16, *September* 17.—Four chickens, inoculated by hypodermic injection, of one cubic centimeter each of virus, containing 1 per cent. of benzoic acid and $1\frac{1}{2}$ per cent. of borax, and allowed to stand four hours after preparation before using.

September 26.—These chickens received a second hypodermic injection of two cubic centimeters each of virus, treated with same proportion of benzoic acid and borax as above. Have remained in good health.

13.—EFFECT OF SULPHURIC ACID ON VIRUS.

Experiment No. 17, *August* 25.—Two chickens inoculated, by four punctures, with virus that had been treated with an equal volume of 1 per cent. solution of sulphuric acid, making the whole contain one-half per cent. of acid, and allowed to stand four hours before using The coagulum and fluid parts both carefully inserted into the punctures. The chickens did not contract the disease. The activity of the virus and susceptibility of the birds both proved by other inoculations.

Experiment No. 18, *September* 17.—Four chickens receive a hypodermic injection of one cubic centimeter each of virus that had been made into a one-half per cent. solution of sulphuric acid, and allowed to stand four hours before using.

September 18.—Yellow coloration of urates.

September 22.—Two have little appetite, droop, urates still yellow.

September 30.—All are well.

October 14.—Still well; used for other experiments.

In this experiment the slight sickness was believed to be due to the irritating effects of the sulphuric acid.

Experiment No. 19, *September* 6.—Two chickens inoculated by four lancet punctures with virus, made into a one-eighth of 1 per cent. solution of sulphuric acid, and allowed to stand four hours before using.

September 13.—One sick.

September 15.—One dead.

September 26.—The second dies.

A solution of sulphuric acid of 1:800 is consequently too weak to destroy the virus, but a solution of 1:200 is perfectly reliable.

14.—EFFECT OF ALCOHOL ON THE VIRUS.

Experiment No. 20, *August* 25.—Two chickens inoculated with virus that had been treated with an equal volume of a 40 per cent. solution of absolute alcohol. This was allowed to stand five hours before using.

August 30.—Urates tinged with yellow.

September 1.—One dead.

September 4.—Second dead.

15.—EFFECT OF BORACIC ACID AND SULPHATE OF POTASSIUM ON VIRUS.

Experiment No. 21, *August* 25.—Two chickens inoculated with virus that had been mixed for five hours with an equal volume of a 4 per cent. solution of a mixture of equal parts of boracic acid and sulphate of potassium.

September 1.—One bird voids large quantities of excrement with yellow urates.

September 6.—One dead.

The second proved insusceptible, and has since resisted inoculations with pure virus.

Dr. De Kleuze, of Munich, is said to have recommended this mixture as being better adapted to preserve milk, butter, meat, fish, &c., than any other antiseptic. One gramme (15 grains) being added to one liter of milk or one-fourth pound of butter, the former being less than one-tenth per cent. and the latter less than 1 per cent. The resistance of this virus to a 2 per cent. solution indicates a fundamental difference in the nature of this virus and the septic organisms.

16.—Effect of boracic acid on virus.

Experiment No. 22, *August* 25.—Two chickens inoculated with virus made into a 1 per cent. solution of boracic acid, and allowed to stand six hours before using.

September 1.—Urates tinged with yellow.

September 2.—Both sick.

September 3.—One dead.

September 6.—Second dead.

17.—Effect of carbolic acid on virus.

Experiment No. 23, *August* 25.—Two chickens inoculated with virus made into a 1 per cent. solution of carbolic acid and allowed to stand six hours before using. Both remained healthy up to October 21, when one contracted the disease "spontaneously."

Experiment No. 24, *September* 17.—Four chickens inoculated, by hypodermic injection, with one cubic centimeter each of virus, that had been made into a 1 per cent. solution of carbolic acid five and one-half hours before using.

September 26.—Receive a second hypodermic injection of the same quantity of virus, containing the same proportion of carbolic acid.

October 14.—All are still well.

18.—Effect of carbolated camphor on virus.

Experiment No. 25, *August* 25.—A solution of carbolated camphor was made by dissolving camphor gum to saturation in a 90 per cent. solution of carbolic acid. This was then added to sufficient water to make a 2 per cent. solution; and a portion of this was mixed with an equal volume of virus, so that the resulting mixture contained 1 per cent. of the carbolated camphor. After standing six hours, two hens were inoculated by four lancet punctures each.

September 1.—One hen sick; has diarrhea; voids mostly urates tinted yellow.

September 2.—Both sick.

September 4.—One dead.

September 6.—Second dead.

The camphor, therefore, instead of proving an advantage, has enabled the virus to resist the action of the carbolic acid.

19.—Effect of iodine on virus.

Experiment No. 26, *September* 6.—Two chickens inoculated with virus which had been treated four hours before with $\frac{1}{1000}$ part of iodine and $\frac{1}{500}$ part of iodide of potassium.

September 13.—One dead.

The other proved insusceptible, and has resisted subsequent inoculations and exposure in an infected coop.

20.—Effect of heat on virus.

Experiment No. 27, *August* 25.—Two chickens inoculated with virulent blood, that had been hermetically sealed in a glass capillary tube, and placed in boiling water for five minutes. These remained perfectly

healthy till September 30, when they were inoculated with active virus. One died and the other proved insusceptible.

Experiment No. 28, *September* 1.—One hen and one chicken inoculated by four lancet punctures, with blood that had been heated to 160° F. for fifteen minutes, have remained in perfect health, and prove insusceptible to subsequent inoculations with active virus.

Experiment No. 29, *September* 1.—Two chickens inoculated by four lancet punctures, with virulent blood that had been heated to 150° F. for fifteen minutes, remained in perfect health till September 17, when they were inoculated with active virus to test susceptibility. Both contracted the disease and died—one September 26, the other two days later.

Experiment No. 30, *September* 1.—Two chickens inoculated by four lancet punctures each, with blood that had been heated to 140° F for fifteen minutes. Both remained in good health till September 17, when they were inoculated with active virus. One died September 26, the other proved insusceptible.

Experiment No. 31, *September* 1.—Two chickens inoculated with virulent blood that had been heated to 132° F. for fifteen minutes, four punctures each, remained in good health till September 17, when they were inoculated with active virus. One died September 27, the other had the disease in a mild form and recovered.

Experiment No. 32, *September* 6.—Two chickens, inoculated by hypodermic injection, of one cubic centimeter each of virus, that had been heated to 140° to 148° F. for two hours. No result.

Experiment No. 33, *September* 26.—Four chickens inoculated with virulent blood that had been heated to 145° F. for one hour. Hypodermic injection of one cubic centimeter each.

September 30.—They receive a second injection of 1½ cubic centimeters each of virulent blood that had been heated to 145° F. for two hours. All remained in good health.

Experiment No. 34, *September* 17.—Four chickens each receive a hypodermic injection of one cubic centimeter of virus that had been heated to 135° to 138° F. for one-half hour.

September 23.—Two chickens dull, little appetite, some diarrhea. No other symptoms noticed and September 30 all were in perfect health.

Experiment No. 35, *October* 25.—Three chickens inoculated, by four lancet punctures each, with virulent blood that had been heated to 130° F. for fifteen minutes.

November 1.—Yellow urates.

November 2.—Plainly sick.

November 6.—One dead.

November 8.—Remaining two dead.

Experiment No. 36, *October* 25.—Two chickens inoculated by four lancet punctures each, with virus that had been heated to 128° F. for fifteen minutes. Neither contracted the disease.

Experiment No. 37, *October* 25.—Two chickens inoculated by four lancet punctures each, with virulent blood that had been heated to 126° F. for fifteen minutes.

October 27.—Yellow urates.

November 2.—One dead.

The other did not contract the disease.

Experiment No. 38, *October* 25.—Three chickens inoculated by four lancet punctures each, with virulent blood that had been heated to 124° F. for fifteen minutes.

October 27.—Yellow urates.
November 5.—Plainly sick.
November 7.—Two dead.
The third insusceptible.

21.—ONE ATTACK OF THE DISEASE PROTECTS AGAINST THE EFFECT OF SUBSEQUENT INOCULATIONS.

Experiment No. 39.—Three fowls used: one was the hen pronounced entirely recovered August 29 (experiment No. 11); the second was a hen that had entirely recovered August 20; the third was a cockerel that had a mild attack and recovered about September 25. The two hens had a very severe attack.

October 14.—Inoculated by four lancet punctures each, with virulent blood. All remain in perfect health.

22.—A CERTAIN NUMBER OF FOWLS RESIST INOCULATION.

Since beginning my experiments with this disease, I have inoculated in all about ninety-five fowls (up to November 1). Of these, two had the disease severely and recovered; three have had it mildly and recovered; and twenty-five others now resist both inoculation and exposure in an infected coop. Whether any of the twenty-five have had the disease in a form so mild as to escape observation, or whether they all have had from the first a natural insusceptibility, it is, of course, impossible to say. Fowls are frequently quite sick when the first symptoms are noticed.* The yellow coloration of the urates in the excrement has, in all cases, been the earliest symptom observed; at this time the temperature may be one or two degrees higher than normal, or it may not be appreciably affected. But I find this coloration is not an infallible sign of the malady; in some cases a slight yellow tinge or even a distinct coloration may occur when no exposure has taken place; while often it occurs within a day or two of inoculation and before the disease has had time to develop, disappearing again till the incubation is finished. Hence, this is a somewhat uncertain criterion as to the mild cases.

Again, drooping, sleepiness, and loss of appetite frequently do not occur until the disease is considerably advanced.

With these explanations, the following statement is made as the result of my observations on this point: Of the ninety-five fowls inoculated the result is not yet (November 1) known in regard to fifteen. Of the eighty remaining, six have recovered, twenty-five have not been visibly affected, and forty-nine have died. From these experiments, then, we might conclude that if one hundred fowls were inoculated with the ordinary virus, sixty-nine would take the disease, and of these sixty-two would die and seven recover; while thirty-one would not be visibly affected. This result may be more or less misleading, however, since, in one lot of twenty, fourteen proved insusceptible, two were slightly affected and recovered, and only four died; it is evident, therefore, they had, before coming into my hands, been subjected to conditions which enabled them to resist the effects of the virus in a most remarkable manner. Leaving this lot out of consideration, and of sixty fowls inoculated forty-five have died, four have been affected and recovered, and eleven only have proved insusceptible. From this we might conclude that by inoculating one hundred ordinary fowls, we would have seventy-five deaths, seven recoveries, and eighteen that would prove insusceptible.

23.—Devitalized virus as a preventive.

One of the most important advances in our knowledge of the phenomena of contagia, is the discovery of Toussaint,* made during the present year, that inoculation of susceptible animals with anthrax blood previously heated to 55° C. (131° F.) for ten minutes, enabled such animals to resist subsequent inoculations with active virus. Of course, such an important fact at once led to theories as to how such an effect could be produced, and suggested that the discovery might be extended to other contagious fevers. Chauveau,† who had just discovered that the inoculation of Algerian sheep with anthrax virus during the latter part of the period of gestation, conferred immunity on the lambs subsequently produced, supposed this was due to some substance formed in the body by the multiplication of the parasite rather than to something being subtracted from it by the same means.

The discovery of Davaine that the *Bacillus anthracis* did not penetrate into the blood or tissues of the fœtus, though swarming in the blood of the mother, seemed to indicate that the immunity conferred upon the lambs was due to a soluble substance capable of passing by osmosis from the blood of the mother into that of the fœtus.

Pasteur‡ believed that the non-recurrence of contagious fevers was rather due to something taken from the tissues by a first attack. Toussaint§ believed at this time that he entirely destroyed the parasite by the heat, and even recommended that one-half per cent. of carbolic acid be added to the blood, after being raised to the required temperature, and this allowed to stand two or three days, to make the destruction certain. This view seemed the more reasonable, as Davaine‖ had found several years before that the virus of anthrax was entirely destroyed by being kept at 55° C. for only five minutes, and that it was destroyed in ten minutes at 50° C. I at once determined to test the effects of inoculation with virus devitalized by heat as a preventive of fowl cholera, and for this purpose the following experiments were made:

Experiment No. 40, *September* 3.—It being difficult to obtain sufficient blood, an enlarged liver from a bird found dead this morning was triturated with one ounce of distilled water, and to this was added what blood could be gathered from the body. The whole, strained through a linen cloth, produced a muddy, brownish liquid, which was boiled over a water-bath for ten minutes, and resulted in a clear straw-colored liquid and a brown coagulum. A second straining produced a slightly turbid fluid, which was heated to 180° F., at 9 p. m., to prevent putrefaction.

September 4.—Four chickens received a hypodermic injection of one cubic centimeter each of the fluid described above.

September 6.—A second injection of one cubic centimeter each of same liquid, which had twice been heated to 180° to preserve it.

September 17.—Inoculated by four lancet punctures each with active virus.

September 23.—One or more sick.

September 24.—One dead.

September 27.—Another sick.

September 28.—One nearly dead was killed for examination. The two remaining proved insusceptible.

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* Comptes Rendus, xci (1880), p. 303; Bul. de l'Acad. de Médecine, 1880, p. 753.
† Comptes Rendus, xci (1880), p. 151.
‡ Bul. de l'Acad. de Médecine, 1880, p. 131.
§ The Veterinary Journal, 1880, vol. xi, p. 152.
‖ Quoted by Bouley in Recueil de Med. Vet., 1874, p. 563.

Experiment No. 41, *September* 1.—Eight chickens inoculated with four lancet punctures each. Two with virus that had been heated to 160° F.; two with that heated to 150°; two with that heated to 140°; and two with that heated to 132°; in each case the heat was applied for fifteen minutes.

September 17.—The eight inoculated by four lancet punctures each with active virus.

September 26.—Two die.

September 27.—One dies, and one that has been sick has recovered.

September 28.—One dies. Three prove to be insusceptible.

Experiment No. 42, *September* 6.—Two chickens receive a hypodermic injection of one cubic centimeter of virus that had been heated to 140° to 148° F. for two hours. One of these unfortunately disappeared from its coop before the experiment was concluded.

September 17.—The one remaining inoculated by four punctures with fresh virus.

September 19.—Urates deeply tinted with yellow, though excrement is still solid.

September 23.—Yellow coloration has disappeared, appetite and appearance good. From this time it remained well.

Experiment No. 43, *September* 17.—Four chickens receive a hypodermic injection of one cubic centimeter each of virus that had been heated to 135° to 138° F. for one-half hour.

September 23.—Two seemed dull, with little appetite and some diarrhea; by September 30 they were all in perfect health.

October 14.—Inoculated by four lancet punctures each with active virus.

October 22.—Yellow urates noticed.

October 24.—One dead.

November 1.—The remaining three well.

In view of the fact that 132° has been sufficient to entirely destroy the activity of the virus, it may be doubted if the two that were ailing, after the hypodermic injection, really had a mild form of cholera. This lot belonged to the twenty that were found so insusceptible, and of which one lot of four kept for comparison have been three times inoculated with active virus without showing any signs of disease.

Experiment No. 44, *September* 26.—Four chickens receive a hypodermic injection of one cubic centimeter of virus that had been heated to 145° F. for an hour.

September 30.—Have a second injection of one and one-half cubic centimeters of blood that had been heated two hours to 145° F.

October 6.—One killed by its fellows.

October 14.—Inoculated the three remaining by four lancet punctures each with active virus.

October 20.—Two sick.

October 22.—One dead.

October 23.—One dead.

The third had a mild attack, with yellow urates and loss of appetite for two or three days, and recovered.

Experiment No. 45.—Four chickens receive a hypodermic injection of one cubic centimeter of virus made into a one-half per cent. solution of sulphuric acid and allowed to stand four hours before using.

September 22.—Two have yellow urates and droop, with little appetite.

September 30.—All are well.

The sickness believed to be due to the irritating effects of the sulphuric acid.

October 14.—Inoculated with active virus.

October 25.—One dies; one killed by a wild animal.

October 28.—Yellow urates still noticed.

November 1.—The two remaining are well.

This lot was also part of the twenty insusceptible birds, of which four inoculated for comparison all remained well.

Experiment No. 46, *September* 17.—Four chickens have each a hypodermic injection of one cubic centimeter of virus to which had been added four hours before one per cent. of benzoic acid and one and one-half per cent. of borax.

September 26.—Receive a second injection of two cubic centimeters each of virus prepared as before.

October 14.—Inoculated by four lancet punctures each with fresh virus.

All remained in the best of health.

This lot again was part of the twenty insusceptible birds, and consequently the experiment has only a negative signification.

Experiment No. 47, *September* 17.—Four chickens receive a hypodermic injection of one cubic centimeter each of virus to which 1 per cent. of carbolic acid had been added five and one-half hours before using.

September 26.—Have an injection of one cubic centimeter each of virus prepared as before.

October 14.—Inoculated by four lancet punctures each with active virus.

October 22.—Yellow urates noticed.

October 28.—One dead.

November 2.—Yellow urates still observed.

November 5.—All are well.

These were also a part of the insusceptible lot.

This series of experiments is one of the most difficult from which to draw conclusions of any I have made; and to assist in this I have prepared the following table showing results:

Number of experiment.	Total birds.	Die.	Recover.	Insusceptible.	Die from other causes.
40	4	2	......	2	......
41	8	4	1	3	......
42	2	......	1	......	1
43	4	1	......	3	......
44	4	2	1	......	1
45	4	1	1	1	1
46	4	......	......	4	......
47	4	1	1	2	......
8	34	11	5	15	3
Deduct experiment Nos. 43, 45, 46, and 47, the birds of which were insusceptible	16	3	2	10	1
Results with susceptible birds	18	8	3	5	2

Almost any one who had not followed these experiments from day to day would be likely to arrive at conclusions from them which I am satisfied are not in accordance with the actual facts. Taking the first totals and of thirty-one birds with which the results of inoculation are known, we find that only half as many died as we should expect from the average number of deaths already shown to follow inoculations,

while twice the expected number recovered, and fifty per cent. over the expected number proved insusceptible. But, fortunately, it was shown by direct experiment that sixteen of these birds were for some reason particularly insusceptible; since, when the original lot of twenty was purchased, four taken at random were at once inoculated with active virus and not one of them sickened; they were subsequently inoculated at two different times, with very active virus, and still they remained in perfect health. They were not all so entirely insusceptible as this result indicated, however, since three of the sixteen in these experiments died, and two sickened and recovered in spite of the supposed protective inoculation. The result with this sixteen, then, cannot be construed as favoring the supposition that any degree of immunity was conferred by the previous treatment.

With the remaining sixteen, of which we know the results, there is still a much smaller death rate (eight instead of twelve) than we should expect, and twice the number of recoveries and insusceptible birds. It must be remembered, however, that with so small a number we should not expect our results to be exactly in accordance with the average. Experiment No. 44 is more reliable than any or all of the others, for two reasons: the birds were from a lot known to be susceptible to the disease, and they received two injections, with four day's interval, of relatively large quantities of devitalized virus (pure blood). Not one of these escaped the disease, and two died from exceedingly acute attacks.

I conclude, therefore, that perfectly devitalized virus when injected in considerable quantity, at different times, and for two weeks before inoculation, does not increase the natural ability to resist this disease.

About the time these results were attained I learned that M. Toussaint had reached a similar decision in regard to anthrax; and that of twenty sheep inoculated at Alfort with his prepared virus, four had died and the remaining sixteen were sick but recovered.* His virus was not devitalized then, but its activity was diminished by subjecting it to the high temperature, and its protective influence depended upon the immunity conferred by a mild attack of the disease.

M. Pasteur maintains that he has obtained a mitigated virus of the *choléra des poules*, though at the time of making these experiments he had not yet made public the method by which this result was accomplished. We were encouraged, therefore, to continue our experiments in regard to the effect of temperature on the virus when the former was not quite sufficient to destroy the vitality of the latter.

24.—Attempts to obtain a mitigated virus.

Experiments Nos. 35, 36, 37, and 38 were instituted with a view of determining the effect of as high a temperature as the virus can bear without destruction upon its properties. The result was not what was hoped in view of the effect of such a temperature on the virus of anthrax; indeed, not one of three inoculated with the virus heated to 130° F. for fifteen minutes was able to resist the disease thus induced, and all perished. Of the ten inoculated with virus heated to 124° to 130° F. but four survived, and these were insusceptible to the disease.

25.—Preservation of cultivated virus.

September 9 a flask of sterilized infusion of chicken muscle was inoculated by the process described further on in this report, by which

* H. Bouley. Inoculations préventives du Charbon, Bul. Acad. de Med. 1880, p. 943.

means a pure cultivation of the granules of the virus was obtained; these multiplied and formed a very delicate membrane on the surface. October 26 this flask was opened and examined; it had almost exactly the same odor as when first filled, and there was no trace of putrefaction. To test the activity of the granules after being preserved for over six weeks, I made—

Experiment No. 48, *October* 26.—Two chickens inoculated by four lancet punctures each with liquid and particles of membrane from the cultivation flask.

November 1.—Yellow urates.

November 6.—One dies.

November 13.—The one remaining dies.

Three facts are very apparent from this experiment, viz: (1) the septic bacteria of the atmosphere had not been introduced or the solution would have become putrid, since it was kept for a part of the time in an incubator at 100° F.; (2) the granules seen in the blood had reproduced themselves; (3) they retained their vitality for a period of over six weeks.

Since the above was written the number of the *Comptes Rendus des séances de l'Academie des Sciences* for October 26, 1880, has come to hand, in which M. Pasteur details his process for obtaining a mitigated virus, and states that cultivations in contact with pure air do not entirely lose their activity in six or eight months, or even more, and that cultivations preserved from access of air retain their original virulence for certainly ten months, which is as far as his experiments go.

26.—SUSCEPTIBILITY INCREASED BY COLD WEATHER.

For about three weeks we have been having quite cold weather, the thermometer marking from 14° to 30° F. before sunrise, and I have noticed that during this time the period of incubation seems shorter, and the disease has a more acute form. One of the hens that had a severe attack of the disease and recovered, and which was still kept in an infected coop, died after a day or two of drooping and loss of appetite. Two chickens that had resisted two inoculations with very active virus, have also sickened, one dying November 20, and the other being still sick (November 22). It would seem, therefore, that for some reason the birds become more susceptible as the weather gets colder.

27.—RÉSUMÉ OF RESULTS ATTAINED BY THESE EXPERIMENTS.

It is demonstrated by these experiments that we have in the United States a contagious and inoculable disease of fowls, popularly known as chicken cholera; that this disease is characterized by a yellow or even greenish coloration of that part of the excrement which is separated from the blood by the kidneys; by elevation of temperature, enlargement and softening of the liver, congestion or inflammation of the intestines and mesentery; by diarrhea, drooping, sleepiness, and early death.* The germs of this disease are probably spread through the excrement,† and are taken into the body with the food and drink, and seldom if ever with the inspired air. The blood and tissue juices convey the disease either when inoculated or taken with the food; the bodies do not putrefy as rapidly as those which die from other diseases, and they certainly retain their virulence for thirty-six hours after death—probably much

* See sections devoted to symptoms, etc.
† This point was not demonstrated.

longer. The effect of putrefaction and drying on the activity of the virus was not determined, as the birds inoculated afterwards proved insusceptible to virus known to be active. Infected habitations convey the disease nine days, at least, after the last case of sickness. The period of incubation is much greater than with the disease known by the same name in France, averaging, with forty cases, fully eight days, as will be seen further on. The virus is not destroyed by a 20 per cent. solution of alcohol, by 2 per cent. of boracic acid and sulphate of potassium, by 1 per cent. of boracic acid, by 1 per cent. of carbolated camphor, nor by one-tenth per cent. of iodine. It is destroyed by 1 per cent. of salicylic, benzoic, or carbolic acids, and by one-half per cent. of sulphuric acid; and it is also destroyed by a temperature of about 132° F. maintained for fifteen minutes. One attack protects against the effects of subsequent inoculations; about one-third of the fowls inoculated prove insusceptible to the disease; hypodermic injection of considerable quantities of devitalized virus affords no protection, and, finally, heating to 130° F. or less for fifteen minutes has not modified the activity of the virus.

SYMPTOMS.

The first symptom of fowl cholera is, in the great majority of cases, a yellow coloration of that part of the excrement which is excreted by the kidneys, and which is normally of a pure white; it is this part of the excrement that I have already, frequently, mentioned as the urates. This yellow coloring matter appears while the excrement is yet solid, while the bird presents a perfectly normal appearance, while the appetite is good, and before there is any elevation of temperature. Indeed, it is frequently seen the second or third day after inoculation, and then may disappear for a week or more, to return one or two days before the other symptoms of disease.

In a very few cases the first symptom is a diarrhea, the excrement being passed frequently and in large quantity, and consisting almost entirely of perfectly white urates.

In all cases the diarrhea soon becomes a prominent symptom, the excrement is voided frequently, consists largely of urates suspended in a thin, transparent mucus, and having a deep yellow coloration which may in the later stages of the disease change to a greenish or even deep green color.

With the beginning of the diarrhea the temperature rises, reaching 109° to 110° F., or two to four degrees above the normal; the comb loses its bright hue and becomes pale and bloodless; the appetite is lessened; the wings droop; the bird becomes inactive. Frequently a good appetite is retained to the last, but often the bird is overcome by stupor and sleeps away the last day or two of the disease; in such cases they are only aroused with difficulty, a touch or blow being required.

In the last stages of the disease they have lost greatly in weight, are exceedingly weak, fall over by a touch, and walk with the greatest difficulty.

Death frequently occurs without a struggle, but in the majority of cases there are convulsions and cries.

The duration of the disease varies greatly. Sometimes the bird dies within twenty-four hours after the first yellow coloration of the urates and when but one or two liquid dejections have occurred; in other cases life is prolonged for three, four, or five days, and occasionally for one or even two weeks.

The crop is generally distended with food and loses the ability to force

this onwards to be digested; in all cases except those of the shortest duration the feathers about the anus become soiled with the discharges. If the birds are aroused from their sleep and made to walk, there is at first an abundant evacuation, followed at short intervals by scanty discharges, which, with the frequent contractions of the spincter ani, are evidence of considerable irritation of the posterior part of the intestinal canal.

In most cases the affected birds are very thirsty throughout the whole period of the disease; frequently, however, the thirst is not exaggerated, and in exceptional cases they scarcely drink at all.

When a bird is inoculated with devitalized virus, or when the subject proves insusceptible, a crust forms over the puncture and there is slight hyperæmia of the adjoining parts; but in a few days (four to eight) the redness disappears, the crusts fall off, and no trace of the puncture remains. This may also occur in exceptional instances, when a susceptible bird is inoculated with active virus. Usually, however, in the successful inoculations the crusts are larger and thicker, the redness of surrounding parts is more marked, the blood-vessels are more prominent; and this appearance may be retained for two or three weeks. Often the crusts fall off, leaving a slight elevation, which gives a sensation to the touch of a nodule more firm and resistant than the muscles n which it is situated.

PERIOD OF INCUBATION AND DURATION OF THE DISEASE.

In order to show at a glance the length of the period of incubation and the duration of the disease in individual cases as well as the average, I have prepared the following tables:

Incubation of 40 cases.		Death or recovery (2) of 45 cases.			
Days incubation.	Number of fowls.	Days after inoculation.	Number of fowls.	Days after inoculation.	Number of fowls.
4	4	5	1	16	4
5	2	6	1	18	1
6	7	7	3	20	1
7	6	8	2	21	1
8	9	9	7	23	1
9	3	10	7	27	1
10	4	11	3	32	1
11	3	12	5	Average 11 days.	
18	1	13	2	Average duration of disease, 3 days.	
20	1	14	3		
Average 8 days.		15	1		

The average duration of the disease in the above table is found by deducting the average period of incubation from the average time elapsing between the inoculation and either death or recovery. As there were but two recoveries recorded they do not modify the average of the fatal cases, particularly as one recovered in eighteen days and the other in twenty-seven days after inoculation.

POST-MORTEM APPEARANCES.

The comb is pale and bloodless, but neither dark nor dark blue, as seems to be the case in France. The superficial blood-vessels generally contain but little blood, and there are in most cases soiled feathers about the anus to which the excrement may adhere in considerable quantity.

On opening the body the first organ to attract the attention is the liver, which in nearly every case is enormously enlarged, softened, with blood vessels very apparent; often of a very dark or dark-green color, frequently attached to surrounding parts by false membranes, and as often surrounded by a transparent colorless effusion. In exceptional cases its appearance is nearly or quite normal. The gall-bladder is generally greatly distended with thick, dark bile, which has frequently passed through its walls in sufficient quantity to stain all of the organs in its vicinity.

The crop is generally distended with food, though no special lesions have been noticed here. The proventriculus, ventriculus, succenturiatus, or true stomach, viewed externally often presents a number of circular discolorations about one-tenth of an inch in diameter, which on section are found to be a small clot of extravasated blood. No lesions have been noticed in the gizzard. The small intestines are usually congested, often the mucous membrane is nearly black from engorgement of the blood-vessels, and occasionally the internal surface is the seat of ulcerations of various size and number. In one case a fibrinous plug had formed about midway of the small intestine completely obstructing the passage of the bowel contents; this plug was three inches long and very firm.

The rectum and cloaca generally present deep red lines upon their mucous membrane, evidently the first stage of inflammation, which results in chronic cases in thickening of the walls, especially of the rectum, the desquamation of the mucous membrane and the formation of large ulcerous surfaces. In some cases this thickening and ulceration extends into the colon; and it is generally seen in the chronic or sub-acute forms of the disease in the cæca, the walls of these being thickened, denuded of their mucous membrane and the cavity filled with a plug of coagulated lymph.

The mesentery is generally congested, often greatly thickened and rendered opaque by inflammation. The ureters are distended with yellow urates; the kidneys seem engorged, and on section accumulations of the tenacious, yellow urates are frequently seen. The spleen is generally normal in size and appearance, though frequently enlarged and softened.

The pericardium is sometimes distended with effusion, in which cases there is noticeable hyperæmia of the surface of the heart.

The lungs are often, though not generally, engorged with dark blood; they are seldom if ever hepatized.

The blood-vessels are sometimes filled with a firm clot, and contain but little liquid; at other times the blood does not coagulate at all. It seems to be those cases where the duration of the disease has been longest in which the blood loses its property of coagulation.

In the few cases examined by me in which the disease was contracted from infected premises, &c., the lymphatic glands along the neck appeared much more congested than in cases which resulted from inoculation, indicating, as suggested by Toussaint, that the virus had been taken with the food and absorbed from the mouth or pharynx.

The brain, in the cases examined, has been either normal or not very perceptibly altered.

The muscles at the seat of inoculation are generally reddened, though sometimes perfectly normal; in a few cases, at the point of inoculation, the tissue has been transformed into a whitish, rather firm substance, without definite outline, but disappearing imperceptibly into the substance of the muscle; exceptionally, this has divided from the muscular tissue, and exists as a clearly circumscribed *sequestrum*.

MICROSCOPICAL INVESTIGATIONS.

When the blood from a fowl just dead of cholera, or on the point of dying, is placed under a one-tenth objective or better under a one-fifteenth, a number of peculiarities are observed. The red globules which should be provided with nuclei are mostly without these; and such nuclei are found free, either singly or in clusters, in various parts of the field. There are many globules resembling the red corpuscles in color and appearance, but which are smaller, circular or irregular in form. There are aggregations of spherical, oval, and rod-shaped granules, both clusters and granules varying somewhat in size; there are free granules, spherical in form, of exceedingly small size ($\frac{1}{40000}$th of an inch in diameter), and without motion or in certain cases with simply a molecular (Brownian) motion, and finally there are bodies of a larger, but varying, size, not numerous, transparent and apt to be overlooked; they may be seen apparently in various stages of division. Figure 9 is a drawing from the blood taken from a vein just before the death of the bird and examined as soon as possible; the different changes already mentioned may be observed.

With the exception of the bodies last mentioned, the appearance of the blood in this disease was accurately described by Professor Perroncito, of the Veterinary School of Turin, in a paper presented to the Royal Academy of Agriculture of Turin, in February, 1878; also by M. Méguin, in a communication to the *Recueil de Médecine Vétérinaire*, in January, 1880.

In the present state of uncertainty regarding the nature of the contagion in such diseases, a careful study of the condition of the blood, especially when as virulent as in the disease under consideration, becomes a matter of primary importance, and for this reason I shall enter into some detail regarding the phenomena mentioned.

1. *The free nuclei.*—These are mentioned by Perroncito, without comment as to the cause of the phenomenon; Méguin does not so much as mention them, but figures each of the red corpuscles with its nucles. Nevertheless, in nearly every ordinary preparation of blood I have made, the majority of the red corpuscles were without nuclei, and these were to be found free in various parts of the preparation as seen in Fig. 9.

By the use of osmic acid, however, I was able to demonstrate that the escape of the nuclei occurred either after the death of the bird or after the blood was taken from the veins. Osmic acid has been found of the very greatest service in these investigations; if a drop of blood is placed on a thin cover and immediately inverted for a minute or two over a two or three per cent. solution of this acid, the fumes destroy every vestige of life, and no changes take place for an indefinite time.

Figure 14 is a drawing from such a preparation; here there are no free nuclei, and every red corpuscle has its nucleus in its proper position. By delaying a minute or two before exposing the blood to the influence of this agent, examples may be found illustrating the escape of the nucleus as is shown in Fig. 13.

The escape of the nucleus is evidently, then, what we might call a post-mortem change; at least it does not occur until the vital influences of the living body are no longer exerted upon it, but within a few minutes after the blood is taken from the veins or after the death of the bird. This phenomenon, however, is not peculiar to chicken cholera, but occurs to the same degree and under the same circumstances in the blood from healthy fowls, as I have assured myself by numerous observations.

2. *The so-called hematoblasts.*—Both Perroncito and Méguin speak of the globules, which are generally irregularly round or oval, and smaller than the red corpuscles, and which resemble these in color, as young or proliferating globules (hematoblasts). On the contrary, I think my observations prove them to be the *débris* of red corpuscles destroyed by leucocytes. In watching the movements of the clusters of granules shown in the figures, I found that they were, evidently, leucocytes, though the homogeneous bioplasm was so transparent as to be generally invisible. These leucocytes would move from one red globule to another, and the latter, soon after coming into contact with them, would become distorted in form and break up into globular particles. The leucocyte could be plainly seen in many instances, passing entirely through the red globule and severing it into two or more particles, which assumed the round or oval form. Figure 16 is an exact reproduction of the appearance of this phenomenon. It would seem that the leucocytes feed upon some of the constituents of the red globules; but, as far as I have observed, this, too, occurs after the blood is taken from the veins or after the death of the bird. I know of no evidence leading to the belief that such particles of red globules are living, or that they could in any way grow and again form perfect globules.

3. *The granular bioplasm.*—Early in my investigations my attention was called to the large number of clusters of granules to be seen in the blood; sometimes these granules were spherical, sometimes oval, and often rod-shaped. In the last form they resembled diminutive *Bacilli*. At first I did not suspect that the granules of these clusters were in any way connected with each other; the $\frac{1}{15}$ Tolles objective with excellent illumination did not enable me to make out any homogeneous connecting substance. I wish to insist upon this fact, because recent investigators, in their zeal to establish a particular theory, have declared that, because they did not see particles of bioplasm, these did not exist; and in their cultivations, because they only saw a particular form, no other could be present. When the whole medical world is divided over the question concerning the nature of contagia, as is now the case, such assertions, no matter by whom made, cannot be received as evidence; on the other hand, they must be regarded by thinking men as an attempt to impose upon the confidence or credulity of the reader.

But to return to our clusters of granules. The granules did not move individually, but the whole cluster could at times be seen to change form (Fig. 11). They would assume an oval, round, or dumb-bell shape, then a projection like an arm would be seen to extend itself in a certain direction; at the extremity of this an enlargement would form, which would increase in size until it would become the body of the cluster, and only a narrow arm would extend in the direction of the original cluster. In this way the clusters not only changed form, but they shifted their position, and in a few minutes would move nearly across the field of vision. Coming in contact with a red globule, this would quickly become deformed; the granules would pass through it in various directions, dividing it into two, three, four, or even more parts, which would generally assume a globular form, and become the hematoblasts already mentioned.

These movements of the clusters, plainly amœboid, led to the conclusion that the granules were connected by a homogeneous, invisible bioplasm, that in fact they were the granules of leucocytes; fortunately, I was able to prove this. By exposing portions of the blood on the thin cover-glass to the fumes of osmic acid, these leucocytes were not only killed, but they became visible, and then presented the appearance seen

in Fig. 14. There were now many leucocytes visible where their presence was not before suspected; their outline had become plain, and within the homgeneous bioplasm could be seen the granules.

A more careful examination led me to observe that at the center of the preparation the granules were round or oval, while nearer to the edges of the cover-glass, where there was a better supply of atmospheric oxygen, they had the rod form, and the movements of the leucocytes were more pronounced. The rods were $\frac{1}{56000}$ to $\frac{1}{25000}$th of an inch in length, by $\frac{1}{50000}$th or less in diameter.

4. *The free granules.*—The presence of these was first noticed by Perroncito, in the paper already referred to, and they have since been studied by both Toussaint and Pasteur. These granules are much more numerous in blood taken from the body after death than in that examined during the life of the bird; and, again, they seem less numerous the sooner the blood is examined after being taken from the veins during life. I have noticed that in my best osmic-acid preparations of blood, from the living bird, free granules could scarcely be found.

The granules are extremely small, $\frac{1}{35000}$ to $\frac{1}{50000}$th of an inch in diameter. Some are perfectly spherical; many others show all gradations of a division by fission—first a slight constriction, then advancing more and more toward the dumb-bell form, and, finally, existing as two granules just touching at a point of their circumference.

Granules exactly the same in appearance are seen either on the surface or within the red globules and surrounding the nuclei; they are, also, seen within the leucocytes. Again, one frequently meets granules of the same appearance and in equal number in the blood of fowls supposed to be healthy.

Toussaint and Pasteur have each succeeded in cultivating these granules in suitable solutions. I have also cultivated them by two methods, as follows:

a. Cultivation on slides.—A rather deep glass cell is cemented on an ordinary slide and a drop of distilled water run around within it, next to the wall, to furnish moisture. An ordinary thin cover-glass is carefully flamed and a drop of infusion of chicken muscle well filtered and sterilized by heat is placed on its center; the drop of infusion is next inoculated by touching with the point of a recently heated needle just dipped into the blood. Finally, the thin glass-cover is inverted over the cell and a ring of paraffin, or, what is better, the paraffin-imbedding mixture, is run around it. The slide is then kept in an incubator at 106° F.

If the blood used for the inoculation has been properly obtained, the preparations are seldom invaded by septic organisms. An excellent method of obtaining pure blood is to kill a bird in the last stages of the disease by strangulation, then expose the heart by removing the breast bone, select a capillary vacuum tube with a finely drawn out extremity, and, after flaming it, force through the walls of one of the large vessels near the auricle; break the point across the walls of the vessel, and when entirely filled seal quickly in the flame of a lamp. When to be used for inoculation as above, the tube is again flamed, the point broken, and the needle touched to the blood still within the tube.

In such cultivations the granules multiply rapidly, form zooglœa masses, and, finally, a delicate membrane on the lower surface of the drop. Preparations thus made may be kept under observation one or two weeks without difficulty.

I prefer this arrangement of the slide for such cultivations, but there are two objections to it: 1. The thickness of the drop and the multi-

plication of the granules at its lower surface prevents examination with the highest powers except at its border. 2. The drop of water forming a plano-convex lens, the rays of light are broken and a distorted image is liable to result. For this investigation I have concluded from observation that the second objection is not valid, and that the former is not a serious drawback. Both may be overcome, however, either by using Raurier's cultivation slide, or, as suggested to me by Mr. Charles Stodder, by laying a smaller piece of thin glass on the drop after inoculation; this cuts off the access of air to a certain extent, and, consequently, I have preferred the uncovered drop in practice.

Cultivations on slides are, after all, open to the grave objection that they cannot be prepared without contact with the atmospheric air, and the possible if not probable admission of some of the germs continually floating in it in such vast numbers. Nearly every investigator has been so troubled in this way that the results of his work have been unreliable, if not positively worthless. Is there not some method, then, by which a cultivation may be made without the possible admission of such germs? After a long consideration of this question, I believe I have succeeded in producing an apparatus, by modifying and combining certain points in the methods of other investigators, that answers the conditions as well as could be expected, and that can be arranged from the materials found in any laboratory. It is described in the next paragraph.

b. Cultivation in flasks.—A small German flask, Fig. 19, *A*, of two to four ounces capacity, is fitted with a soft rubber cork pierced with two holes; through one of these passes a glass tube, *e*, $\frac{3}{16}$ inch in diameter, bent twice at right angles, and packed loosely near its outer extremity, *f*, with cotton-wool; through the second hole passes a tube bent once at a right angle, and just beyond at *d* drawn down to about half its previous diameter, and, again, just beyond this constriction, drawn to a sealed point, *c*. One end of a piece of caoutchouc tubing fits over the point *c*, which is here shown in section, while into the other end is placed a fine aspirator needle, *b*; and, finally, a short piece of glass tubing, *a*, sealed at one end and packed with cotton wool is slipped over the needle. In using, the infusion for the cultivating medium is introduced into the flask, the cork is tightly replaced, and the whole apparatus is placed in a dry chamber that can be kept for several hours at 212° F.; after cooling it is allowed to stand for three or four hours, and again heated for one or two hours, and this may be repeated the third time, as is my practice. By this intermittent heating not only the germs in the liquid but in the tubes as well are destroyed.

To charge the infusion thus prepared with virus, a pair of aspirator jars—such as were used by Cohn* in his investigations of bacteria—are attached by caoutchouc tubing *g* to the open tube at *f*; then a large vein in a very sick fowl is laid bare, and a thread passed around it, the glass cap *a* is removed from the needle and this is quickly forced into the vein and the thread well tied around it; finally, the point of the glass tube *c* is broken within the caoutchouc tube by pressure across its walls, and the clip *h* on the tube between the aspirator jars is opened. As soon as a few drops of blood have reached the flask the clip *h* is closed, and the glass tube is severed at the constriction *d*, and at the same time hermetically sealed. Now, removing the aspirator, we have a flask that contains the sterilized infusion inoculated with perfectly pure blood, and this is supplied with pure air which enters through the ventilator *e*, packed with cotton-wool, to filter out all atmospheric germs.

*Beiträge zur Biologie de Pflanzen B. I., H. III, p. 148.

The whole may be placed in an incubator at the desired temperature for any length of time before examining.

By means of this apparatus I have succeeded in obtaining the granules of chicken cholera in large quantity. They multiply rapidly, render the liquid turbid, and finally form an exceedingly delicate membrane on the surface which consists entirely of granules. The membrane on the surface of a flask prepared September 3 was used for the inoculation of two birds October 26, and produced unmistakable cases of the disease, ending in death November 6 and 13.

Any number of generations of pure virus may be cultivated in these flasks without the slightest difficulty; to accomplish this other flasks are prepared as directed for the first generation, with a single exception; in place of the aspirator needle *b* is inserted a short section of glass tubing, sealed at both ends to close the orifice. To inoculate this new flask the point *d* of the original one is well flamed, the point *b* of the new flask is also flamed, the glass tube removed, and the point *d* inserted in its stead; the aspirator jars are now connected with the new flask, the sealed points broken within the caoutchouc tube, the clip *h* opened, and the second infusion receives the virus with the same purity as the first.

I believe the apparatus just described, and which is not so complicated as would appear from the long description, will prove of very great use in investigating other contagious diseases, and may settle points which up to this time have been disputed.

5. *Bodies of undetermined nature.*—These were first noticed in the liquid part of the excrement, in which they existed in immense numbers and of all sizes, from $\frac{1}{100000}$ to $\frac{1}{8000}$ of an inch in diameter, Fig. 17; bodies of similar appearance have since been found in the blood, Fig. 18, and I think I have also made them out in my cultivations, but not with the same certainty. They are not easily discovered, and it was not till within the last few weeks that my attention was directed to them. I have not yet been able to determine their nature or their relation to the disease.

PART III.—INFLUENCE OF RECENT INVESTIGATIONS ON THE THEORIES OF CONTAGIA.

In the two preceding parts I have endeavored to give a detailed report of my most important researches without drawing other than the plainest conclusions from them; but the duty of the investigator does not stop here—others have studied these and similar diseases, and they have constructed theories, some of which oppose while others confirm my own results. And in a time when scientific methods are so justly relied upon in our search for the truth, as at present, no one who really desires the speedy success of those doctrines which are in accordance with the facts, can ignore the work of his predecessors. There is, consequently, a duty devolving upon the writer of such a report, which any one, realizing the difficult nature of the subject, would rather defer until more definite investigations had marked out a plainer course. But if the field is not yet clear, it is, nevertheless, a matter of great importance for us to review the more important evidence, and to reach clear ideas as to what is known, what is yet doubtful, and what seems to be contrary to well ascertained facts.

I.—THEORIES OF CONTAGION AND WHAT IS REQUIRED TO ESTABLISH THEM.

There are three principal theories in regard to the nature of that substance which, transferred from the body of an animal suffering from a contagious disease to the body of a healthy one, produces the same malady in the latter as affects the former.

1. It is considered by some as an unorganized ferment, allied perhaps to diastase, which has the power of producing zymotic changes in the blood and other liquids of the healthy body.

2. By others it is looked upon as a modified form of the living matter—the bioplasm or protoplasm, as it is called, of the body. There are two forms of this theory: *a.* The virus is in the form of naked particles of bioplasm of various sizes and forms, identical in all but vital powers with the leucocytes or wandering cells of the healthy body. *b.* The virus consists of granules of bioplasm, endowed with peculiar vital powers, which leave the wandering cells, and perhaps the protoplasmic contents of other cells, and multiply in the blood and other fluids, constituting the micrococci so frequently, I might say generally, seen in these affections.

3. According to the third theory the virus is a parasitic organism originating outside of the body but capable of growth and multiplication within it. It probably consists of the lowest forms of vegetable life known as the *schizomycetes*, *schizophytæ*, *bacteriaceæ*, or more simply as *bacteria*. There is also a second form of this theory which considers the bacteria as the developed granules or plastids formed in the bioplasm of the higher orders of fungi.

1. *The theory of unorganized ferments.*—The first step toward establishing this theory evidently consists in showing that the conditions of existence of the contagia are different from those of living matter in any form. Panum's* experiments with putrid substances are still accepted by some† as proof that contagia are not living matters, since he proved that a putrid infusion might be boiled eleven hours without losing its activity. Von Raison even found that it resisted several hours' heating to 130° C‡. M. Paul Bert observed that compressed oxygen, which he supposed would kill all living things, did not destroy the virus of glanders and vaccine, even when the pressure was equal to fifty atmospheres for a week§. He supposed that he had proved the same true of anthrax virus,‖ but Pasteur convinced him that he had mistaken septicæmia for anthrax and that the germs of the septic vibrio remained unharmed even after subjection to the action of compressed oxygen and absolute alcohol.¶

The only successful attempts at isolating such unorganized ferments, that I am acquainted with, have been made with septicæmia and putrid poisoning. Panum isolated a putrid extract and a narcotic substance. Dr. Richardson, in 1865, showed that the sero-sanguineous fluid from the peritoneal cavity of a person suffering from pyæmia would communicate fatal disease from one animal to another in a direct series, and that the poison (designated "septine"), which effected this, could be made to combine with acids so as to form salts, which retained the

* Panum, Das putride Gift. Virchow's Archiv., B. 60 (1874), p. 334.
† T. R. Lewis, Quarterly Journal Mic. Science, 1879, pp. 402–3
‡ Hiller, Lehre von der Fäulniss, Berlin, 1879, p. 182.
§ Recueil de Médecine Vétérinaire, 1877, p. 546.
‖ Loc. cit., p. 547.
¶ Loc. cit., p. 919.

poisonous qualities of the original substance.* In 1868, Bergmann and Schmiedeberg† isolated a substance called sulphate of sepsin; in 1869, Zuelzer and Sonnenschein obtained a septic alcaloid similar to atropin‡, while Hiller§ discovered a septic ferment.

I pass over in silence the many other experiments by filtration, diffusion, dialysis, etc., which establish the same fact, viz., that there exists in putrid substances a poison of complex nature, allied to the alcaloids, and not having the properties of a living substance. The bearing of this fact on the doctrine of *contagium vivum* (and in this term I include both the remaining theories) will be discussed when we come to consider the nature of septicæmia.

Notwithstanding the experiments of M. Bert in regard to glanders and vaccine virus, this theory is at this time quite generally deemed insufficient, because an unorganized ferment is incapable of multiplying itself indefinitely; such a substance may cause the decomposition of a definite quantity of matter, but we have no proof that it can reproduce itself, and thus, like the living ferments, produce the decomposition of an indefinite amount of the substance to which it is added, and no fact is better known than that the true contagia have the power to reproduce themselves indefinitely, if placed in a suitable medium.

Again, it would seem that such a ferment ought certainly to resist a temperature of 140° F. (which destroys both chicken cholera and fresh anthrax virus), as, also, one-half per cent. of sulphuric acid, or one per cent. of carbolic, salicylic, or benzoic acids, which destroy fowl cholera virus.

Finally, M. Chauveau‖ has shown with several diseases that the activity of the contagion resides in elementary corpuscles, which are suspended in virulent liquids; that these corpuscles may be washed without losing their specific properties, and that they do not communicate virulence to water by remaining in it for prolonged periods. These facts are in direct opposition to the theory of a soluble poison or unorganized ferment.

2. *The theory of bioplasm or its granules.*—In all contagious fevers there are local inflammations, and in inflammation, no matter how produced, there is an abnormal increase of the bioplasm of the part, both by the influx of vast numbers of wandering cells and by the multiplication of the nuclei of the tissues.

The physiological existence of granules capable of reproduction was assumed by Darwin in order to explain the facts of inheritance. He supposed the living cells of the body throw off minute granules or atoms which circulate freely through the system, multiply by self-division, and are subsequently developed into cells like those from which they are derived.¶ Later, Beale figured vast numbers of small particles of living matter (bioplasts) which he supposed constituted the virus of cattle plague, vaccine, etc.: "The minute contagious bioplast," he says, "is less than the $\frac{1}{100000}$th of an inch in diameter and often so very clear and structureless as to be scarcely distinguishable from the fluid in which it is suspended."** Quite recently it has been shown that certain kinds of cells allow granules of protoplasm to wander from them under certain physiological conditions, and that these granules are not to be

* Referred to by Dr. Lewis, Quart. Jour. Mic. Sc. 1879, p. 403.
† Centralblatt für die medicin Wissenschaften, 1868, p. 397.
‡ Berliner klin. Wochenschr. 1869, p. 121.
§ Lehre von der Fäulniss, p. 188.
‖ Recueil de Médecine Vétérinaire, 1872, pp. 898–9.
¶ Animals and Plants under Domestication, II, p. 448.
** Disease Germs, p. 243.

distinguished in appearance and reaction to coloring matters, at least from those found in contagious diseases, and termed micrococci.* In both swine plague and fowl cholera I have observed what appeared to be similar swarming of granules, but I have not yet been able to determine if such granules are identical with those which multiply in the cultivation liquids, or if either constitute the virus of these diseases. We may, by filtering experiments, decide that the contagion consists of solid particles, but to determine the nature of these is a much more difficult question.

There is a different line of experimenting which seems to support the view that the contagious particles are formed from the normal constituents of the living body. Hiller,† in 1872, showed that the products of inflammations produced by chemical agents were of a contagious nature, and might be successfully inoculated. Burdon-Sanderson has shown that exudation liquids, even in extremely small quantity, when mixed with the blood stream produce pyrexia,‡ and, also, that acute inflammations produced by physical or chemical means are transmissible.§ Lewis and Cunningham have, also, shown "that the living tissues of the body will, under certain conditions, when irritated by means of purely chemical irritants—such for example as a strong solution of iodine or liquor ammonia—secrete a fluid which, transferred from animal to animal, proves not one whit less virulent in its properties than an exudation which has resulted primarily from the introduction into the system of material which has swarmed with bacilli."‖

3. *The bacteria theory.*—In this section I shall confine myself to the forms, distribution, and peculiarities of the schizomycetes, and to certain general facts bearing on the question, in order to show what kind of evidence is necessary to demonstrate their pathogenic action. The observations in regard to their relation to contagious diseases will be more conveniently considered in the study of certain virulent diseases.

a. The nature, form, and classification of the bacteriaceæ.—Comparatively recent investigations have shown that in all putrefying animal and vegetable matters are to be found vast numbers of exceedingly minute organisms, existing either in the form of filaments (threads), or granules (spherical or oval), and that if these are excluded such matters may be preserved indefinitely. These organisms are emphatically the lowest forms of life, and are probably of a vegetable nature, though in many cases capable of the most active movements. When we examine with the microscope an infusion of meat that has commenced to give off offensive gases, we find that there are a variety of forms to be observed under powers of 500 to 1,000 diameters; there are spherical and oval granules, frequently of different sizes; plain stiff rods, jointed or single, varying in diameter from $\frac{1}{20000}$th to $\frac{1}{40000}$th of an inch, some moving and others perfectly motionless; other rods containing very apparent round or oval granules; filaments, short or long, flexible and moving by an undulating, wavy, vibratory or screw-like motion, and even filaments coiled in a spiral form. These are the *schizomycetes* of Nägeli, the *schizophytæ* of Cohn and the *bacteriaceæ* or bacteria of most writers; they are the active agents of putrefaction, and without them no decomposition of this nature can occur;¶ putrefaction in reality consists in the

* G. & F. E. Hoggan, Jour. Roy. Mic. Soc., 1879, pp. 375 to 380.
† Lehre von der Fäulniss, p. 165.
‡ Veterinarian, 1873, pp. 719–20.
§ On the Infective Product of Inflammation. Lancet, 1873, No. 21.
‖ T. R. Lewis, Quart. Jour. Mic. Science, 1879, p. 403.
¶ F. Cohn, Beiträge zur Biologie der Pflanzen, II, 1872, p. 203.

assimilation of certain substances which are proper for the food of these organisms, and its decomposition by the living matter within them; it is exactly analogous to the assimilation of food by the higher animals, and the decomposition of this into both gaseous and solid parts which occurs in the animal body, as a consequence of the activity and growth of its living constituents.

This much understood, any one is prepared from personal observation to appreciate the immense number and wide distribution of these organisms, for all know how soon an animal body, a piece of meat, or even vegetable matters become putrid if kept in certain conditions of heat and moisture.

With the exact place of these organisms in nature we have not much to do; such studies are the work of the naturalist, not of the pathologist, but it is well for us to know the widely different opinions that have been entertained in regard to them. They were formerly thought to be of an animal nature, but now most authorities consider their place to be in the vegetable kingdom, though some go so far as to create a new kingdom between the animal and vegetable to which they are consigned.* Hallier † has long taught that they are simply the developed granules of protoplasm or plastids of different varieties of fungi; Karsten ‡ and Grimm § believed they may be formed from the granules of animal protoplasm by the breaking up of the cells containing this.

When we come to consider the classification of bacteria we are again confronted by the same unsatisfactory state of the knowledge concerning them. Billroth ‖ maintains that all of the different kinds of bacteria are simply vegetation forms of the same organism; the granules he calls *coccos* and the filaments *bacteria*. According to the diameter the former are divided into *micro-*, *meso- and mega-coccos*, and the latter into *micro-*, *meso- and mega-bacteria*. These elements may exist singly, in pairs, or in chains, and for these he proposes the terms *monococcos*, *diplococcos*, and *streptococcos*, and *monobacteria*, *diplobacteria*, and *streptobacteria*. During multiplication a mucus-like matter (glia) is secreted, and as the growth occurs particularly on the surface of liquids, a thin, cohesive membrane is the result; this, when formed of granules, is called *petalococcos*, and when of filaments, *petalobacteria*. The granules multiply to a certain depth in the liquid, by which means flocculent, cloudy masses are produced, which he calls gliacoccos; this term being synonymous with the zooglœa of F. Cohn. Now these different forms, though growing either as coccos or bacteria for a number of generations, are looked upon as capable of changing or developing from one to the other, and the several forms specified are considered as constituting but a single organism, which he calls *Coccobacteria septica*.

Nägeli's ¶ views in regard to the classification of bacteria approach somewhat those entertained by Billroth; while he holds it still necessary to speak of the different forms as micrococcus, vibrio, bacterium, and spirillum, he says he cannot assert that there is any necessity for dividing them into even two specifically different forms.

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* Ant. Magnin, Les Bactéries. Paris, 1878, p. 42.

† Hallier, Die Pflanzlichen Parasiten des Menschlichen Körpers, Leipzig, 1866. Also Die Plastiden der niederen Pflanzen, etc., 1878.

‡ Die Plastiden der niederen Pflanzen, Leipzig, 1878, p. 79.

§ Veterinarian, 1874, p. 163.

‖ Dr. Th. Billroth, Unntersuchungen über Vegetations Formen von Cocobacteria Septica, etc., 1874.

¶ Die niederen Pilze in ihren Berziehungen zu den Infectionskrankheiten, etc. München, 1877, pp. 20 to 24.

Davaine's* classification as a means of distinguishing the different forms has been quite widely adopted in practice and is perhaps the simplest of all; it is as follows:

1. Filaments straight or bent, but not twisted into a spiral.			2. Filaments twisted in a spiral form.
A. Moving spontaneously.		B. Immovable.	
a. Rigid.	*b.* Flexible.		
Bacterium.	Vibrio.	Bacteridium.	Spirillum.

The views of Cohn are very different from those of Billroth and Nägeli. He says: "I consider myself authorized, where to a certain bacteria-form peculiar physiological phenomena are constantly bound, particularly if this is a specific fermentation, to look upon the same as a substantial species, even if under the microscope I am able to perceive no other distinguishing mark." † Pasteur also regards as a particular species such forms as constantly arise in a special medium or which cause a certain specific fermentation. ‡

The objections of Nägeli to such views are founded upon the following observations: In the first place, he has noticed, in the same decomposition, the presence of several different forms of *schizomycetes*; again, in decompositions entirely different one may observe *schizomycetes* exactly alike according to their external form, and, finally, the physiological action of a particular form may be changed by causing it to undergo certain treatment. For this author and investigator, who certainly ranks among the highest authorities, the form and action of bacteria are probably due to a sort of acclimatization, and these change with different conditions of life. Not only may each species assume the forms of micrococcus, bacterium, vibrio, and spirillum, but each is also capable of causing lacteal acid formation, putrefaction, and different forms of disease. §

Most pathologists, however, seem inclined to adopt the views of Cohn. This is especially true of Koch, ‖ whose great ability in this class of investigations is now universally admitted. He concludes that there is an internal difference in the pathogenic bacteria, and that the particular forms of the different kinds are constant. Each variety of septic disease represented a particular bacteria-form, which always remained the same no matter how many times inoculated. These forms are well characterized by their size and shape, as well as by their physiological effects and manner of growth. There are, consequently, bacteria which are pathogenic and those which are not pathogenic.

The tendency of the most recent investigations seems to favor the views of Cohn and Koch. Thus, the contagium of charbon—the *Bacillus anthracis*—always exists in the blood and tissues during life in the form of rods, while after death these rods grow to long filaments and form spores; but these spores are very different from micrococci. They do not multiply by fission and form gliacoccus masses, and they resist external conditions (temperature, &c.) that would be fatal to true micrococci. In other words, this organism has fixed vegetation-forms, through which it develops, and in which alone it exists. Chicken-

*Quoted by Richardson in Handbook of Medical Microscopy, 1871, p. 104.
† Beiträge zur Biologie der Pflanzen, H. III, 1875, p. 142.
‡ Maguin, Les Bactéries, p. 49.
§ Die niederen Pilze, etc., pp. 22–24.
‖ Dr. Robert Koch, Untersuchungen über die Aetiologie der Wundinfectionskrankheiten, Leipzig, 1878.

cholera virus also exists in a particular form—that of granules or micrococci—and it has never been seen to develop into any other form. The septic vibrio of Pasteur and the different pathogenic organisms studied by Koch each have a definite method of reproduction and development, from which they do not depart. The idea that septic bacteria may be transformed into the contagious germs of other diseases than septiæmia—that is, that such maladies may arise spontaneously by exposure to filth and to the products of organic decomposition—may be said to be losing ground, and the view now most generally adopted by leading thinkers is that every case of such disease arises from germs that have been produced by a previous case of the same disease.

Among this great variety of conflicting opinions it is impossible at present to make a satisfactory choice. This is the first difficulty in our present study. Admitting the bacteria theory of contagion to be correct, are we to expect to find a particular bacteria-form in each contagious disease, or may the contagion exist under the various forms of micrococcus, bacillus, vibrio, or spirillum?

Even if we find the virus is always constituted by a particular form of organism, it seems impossible to leave entirely out of consideration the physiological peculiarities; for the classification by form alone must of necessity be extremely unsatisfactory. For instance, the spherical bacteria may exist all the way from $\frac{1}{50000}$th of an inch, or even less, up to $\frac{1}{20000}$th of an inch in diameter, and supposing we could accurately measure each $\frac{1}{50000}$th of an inch (which we cannot), at what points are we going to make our limits for each variety? The same argument applies with the same force to the *Bacilli*. We will take an example. Dr. Detmers, in his investigations of swine-plague, found a particular *Bacillus*, which he describes, and which he has gone so far as to classify into a separate variety, that he calls *Bacillus suis*.* It is about $\frac{1}{35000}$th of an inch in diameter and $\frac{1}{8000}$th to $\frac{1}{5000}$th of an inch in length. In examining specimens of dew and well water, which had an opportunity, he thinks, to become infected through the air, he found what he supposed was the same *Bacillus*. Now, the question is, can the dimensions of these *Bacillus* rods be taken as always indicating this variety?

Within the last thirteen months I have carefully examined over one hundred putrefying solutions and I have found in the great majority of them, at some period of putrefaction, a *Bacillus* of exactly these dimensions, and that in a section of the country entirely free from swine plague; I have gone farther and inoculated pigs with one or two cubic centimeters of the liquids swarming with such *Bacilli* without producing the least results. We must conclude, therefore, that there is a septic bacterium having these dimensions, and we may ask what certainty can there be that the dew or water did not contain this and not the swine plague contagium?

Again, it may be asked, who would undertake to distinguish by appearance and measurements alone between *Bacillus subtilis*, *Bacillus anthracis*, and *Bacillus amylobacter*? Even so good an authority as M. Pasteur, who has made a specialty of such studies for more than twenty years, recognizes to such an extent the difficulty of determining the species of bacteria that he writes: "I have generally abstained from giving specific names to such of these organisms as I had reason to believe were new."†

Taking into considertion then the confusion which still exists in regard to the classification of the *schizomycetes*, and the difficulty of de-

* Department of Agriculture Report, 1878. † Comptes Rendus, lxxxviii, 1879, p. 1214.

termining between many of those varieties which have been best studied, we can appreciate the importance of knowing something of the distribution of these organisms in nature, and of learning to just what extent we are liable to meet with them outside of the tissues and fluids of animals affected with contagious diseases.

Since writing the above, one of the most satisfactory classifications of the genera of the Bacteriaceæ that I have yet seen has come under my eye, and I insert it as the latest contribution to the subject.*

I. Cells not united into filaments, separating immediately after division, or in couples, free or united into colonies (Zooglœa) by a gelatinous substance.
  A. Cells dividing in one direction only.
    a. Cells globular: *Micrococcus.*
    B. Cells elliptical or shortly cylindrical: *Bacterium.*
  B. Cells dividing regularly in three directions and thus forming cubical families, having the form of pockets strung crosswise and consisting of 4, 8, 16, or more cells: *Sarcina.*

II. Cells united into cylindrical filaments.
  A. Filaments straight, imperfectly segmented.
    a. Filaments very fine and short, forming rods: *Bacillus.*
    B. Filaments very fine and very long: *Leptothrix.*
    γ. Filaments thick and long: *Beggiatoa.*
  B. Filaments wavy or spiral.
    a. Filaments short and stiff.
      a. Filaments slightly wavy, often forming woolly flocks: *Vibrio.*
      b. Filaments spiral, stiff, moving only forward or backward: *Spirillum.*
    B. Filaments long, flexible, with rapid undulations, spiral through their whole length, and endowed with great mobility: *Spirochæte.*

b. Distribution of schizomycetes in nature.—Dr. Burdon-Sanderson has shown that the spores or germinal matter of bacteria are universally present in water,† and with the assistance of Professor Tyndall he demonstrated their presence in the heart of the clearest blocks of Norway ice.‡ The presence of bacteria in distilled water was pointed out by Tyndall,§ and in my own investigations I have had occasion to confirm this only too often; indeed, it has been almost impossible for me to keep such water free from them for more than an hour or two after distillation.

In regard to the presence of bacteria or their germs in the air, there has been a greater difference of opinion, but the later investigations have removed all doubts. Tyndall, from his experiments, concludes that the air contains vast numbers of them. "There are billions of them," he says, "in every ordinary London room."‖ Beale¶ and Hiller** also insist upon this fact, while Miguel,†† the most recent investigator, has succeeded in counting such germs, and has frequently found as many as one thousand in a cubic meter of air; but the number varies greatly with the season of the year, the moisture of the atmosphere, &c.

It is plain from the above observations that the food and drink, and even the air inspired, are bearers of bacteria into the bodies of every living animal. Tyndall‡‡ has even shown that the lungs retain these germs, and that the expired air is perfectly free from them; while many observers have met with bacteria in immense numbers in the mouth and

* Dr. Luerssen, Rev. Internat. Sci., iii, p. 242, quoted in Jour. Roy. Mic. Soc., 1880, p. 837.
† John Tyndall, Fragments of Science, p. 23.
‡ Loc. cit., p. 24.
§ Loc. cit., p. 23.
‖ Loc. cit., p. 21.
¶ Microscope in Medicine, 1878, pp. 317, 318.
** Lehre von der Fäulniss, p. 145.
†† Comptes Rendus, xci, 1880, p. 64.
‡‡ Loc. cit., pp. 2, 3.

alimentary canal in health as well as in disease. H. T. Butlin* has lately found in the mouth micrococcus, *Bacillus subtilis*, *Bacterium termo*, *Sarcini ventriculi*, *Spirochæte plicatilis*, and a larger form of *Spirillum*. In addition to these I have found in the mouth in health a *Bacillus* about $\frac{1}{35000}$th of an inch in diameter, or much finer than *Bacillus subtilis*.

c. Effect of inoculation with, and of injecting bacteria solutions into, the tissues and vessels.—Koch† inoculated animals with decomposing vitreous humor, in which a variety of *Bacillus* had developed, which in size and appearance exactly resembled *Bacillus anthracis*, but anthrax was not produced in any case; other animals inoculated with *Bacillus subtilis* remained sound. Hiller‡ has taken bacteria in the most different forms, and at different stages of development, that were produced in blood-serum, albumen solution, meat infusion, urine, and cultivation fluids, and separated them by filtration, diffusion, freezing, and skimming from the surface, and placed in distilled water. Their vitality was then tested by adding a drop to some of Pasteur's solution, sterilized by heat, and in all cases produced a luxuriant growth. Dogs, rabbits, and frogs were inoculated in over one hundred experiments with 0.5, 4, and even 8 cubic centimeters in one or several doses, without producing inflammation, fever, or other symptoms. The same author§ injected bacteria cultivated in Pasteur's solution, and in some cases produced inflammation, abscess, or fever; while in others they were entirely without result. In the positive cases a much larger dose was required to produce the effect than with putrid blood or pus. Hiller thinks the experiments of Lewitzky and Andus show the toxic effect of these solutions to be independent of the bacteria; but the experiments of Chauveau‖ certainly demonstrate that the inflammatory effects of putrid pus is due to the bacteria, since when filtered the serum was inactive, but regained its properties with a new development of these organisms. Hiller¶ did not succeed in causing suppuration in wounds of rabbits by covering them with milliards of bacteria, nor were suppurating wounds on dogs aggravated by irrigating daily with isolation solutions rich in bacteria.

I have many times injected one or two cubic centimeters of various solutions, swarming with the different bacteria forms, beneath the skin of pigs without producing any appreciable result.

We must, therefore, conclude that the ordinary septic bacteria, either in the form of micrococcus, bacillus, vibrio, or spirillum are not injurious to the health when taken with the food and drink, when inspired with the air we breath, and, in most cases at least when inoculated or injected into the tissues.

d. How bacteria injections may be rendered injurious.—If bacteria do not multiply in the tissues when introduced under ordinary circumstances, it is because the living matter of the tissues exercise an influence over them which keeps them in abeyance. Thus we have seen that so long as Hiller inoculated with pure bacteria no effect was produced, but when he injected with them the solution in which they were produced, and which also contained their decomposition products, inflammation, abscess, and fever were, at times, produced. Chanveau** has shown that the serum of putrid pus has toxic qualities which, though it does not produce irritating effects itself, greatly increase the

* Journal Roy. Microscopical Society, 1879, p. 756.
† Beiträge zur Biologie der Pflanzen, B. ii, H. ii, p. 298.
‡ Lehre von der Fäulniss, pp. 176–7–8.
§ Loc. cit., pp. 172, 173.
‖ Recueil de Médecine Vétérinaire, 1872, p. 912.
¶ Loc. cit., p. 178.
** Recueil de Médecines Vétérinaire, 1872, p. 917.

effects of the solid particles when injected with them. Zuelzer and Riemschneider* found that though bacteria cultivated artificially and introduced in considerable quantity into the mouth, under the skin, and into the vessels of different animals never appeared to provoke septic accidents, the result was different when two to five centigrammes of neutral sulphate of atropin was added to the matters injected. Hence it would appear that when the vitality of the tissues is overcome by the action of a toxic agent, the bacteria find these, as well as the alimentary canal, in health, a suitable place and medium for their development and multiplication.

If, then, the septic bacteria may multiply in parts of the body where the vitality has been impaired by such toxic matters, it becomes an important question to know if they may not also be developed in other than contagious diseases or in diseases in which their pathogenic action could not be suspected. The first step in this inquiry is to learn if the germs of these organisms find their way into the blood and tissues during health; and the question is so important, that I devote the next section to its consideration.

e. Do bacteria germs penetrate into the blood and tissues during health.—Pasteur insists that the liquids of the healthy animal body, the blood and urine for example, do not contain either bacteria or their spores; that the body is closed against the introduction of these external germs.† Koch‡ also considers the view untenable that the bacteria found in the blood and tissues of living animals sick with septicæmia are the riper forms, which develop from germs continually present, as the result of destructive changes in this fluid; for he, as well as Pasteur, Burdon-Sanderson, and Klebs, has never succeeded in finding bacteria in the blood or tissues of healthy animals or men.

In examining blood from my own finger I have frequently found a considerable number of rotating spherical and oval granules, the latter exactly resembling the spores of *Bacillus subtilis*. There may be two objections brought against these observations: 1. The granules gained entrance from the air. 2. They were not spores, but lifeless particles, perhaps of fibrin. In reply to the first, I will simply give my method of making the observation. A slide and cover glass are first well flamed, then the finger and needle used are passed several times slowly through the flame, and the puncture immediately made; the drop of blood that issues is at once touched to the cover glass, which is handled with flamed forceps, and this is inverted on the slide and immediately examined. In regard to the second objection, I do not consider any test of value except a direct cultivation experiment, made with suitable precautions, and here I can only offer the researches of others.

J. Béchamp§ coagulated the surface of pieces of horse-meat by boiling for ten minutes; he then wrapped them in closely-woven cloth, and after eight days found them in an advanced stage of decomposition, while bacteria and vibrios abounded. Dr. Lewis|| found that when organs of chloroformed animals were separated by ligature before death and immediately removed and dipped into melted paraffin or wax, by means of the attached string, bacteria developed almost, if not quite,

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*Quoted by Magnin, Les Bactéries, p. 130.

†L. Pasteur, Études sur la Bière, ses Maladies, Causes qui les provoque, procédé pour la rendre inalterable, avec une Theorie Nouvelle de la Fermentation, Paris, 1876, p. 46.

‡Virchow's Jahresbericht über die Leistungen und Fortschritte in der Gesammten Medicine, 1878, B. I, Ab. II, p. 288.

§Jour. Roy. Mic. Soc., 1880, p. 411, from Comptes Rendus, lxxxix, 573.

||Quarterly Journal Micros. Science, 1879, p. 388.

as soon as in the bodies of animals which had been simply set aside under like conditions. Professor Tiegel* made many experiments with different organs of freshly-killed animals, by dipping them, as soon as they could be removed, into paraffin heated to 110° to 150° C., and preserving with a coating of this. He found in most instances that bacteria developed in the unheated center. Dr. Burdon-Sanderson repeated these experiments, always finding bacteria.† Chiene and Cossar Ewart,‡ by using, in addition, an antiseptic spray, came to a different conclusion, and thus threw doubts on all preceding experiments. Finally, Nencki and Giacosa § extracted slices of organs of rabbits with great care, under a spray of carbolic acid, and dipped them into a bath of molten Wood's metal (m. p. 75° C.) until the metal solidified around the fiber. In other cases they collected the organs in tubes filled with mercury, placed in bath at 120° and allowed to stand some days at 40°. The metals were previously heated sufficient to destroy all germs, and the baths were covered with a layer of carbolic acid solution. In both cases putrefaction set in after a few days.

The weight of experiment is, consequently, very much in favor of the view that bacteria germs do gain entrance into the blood and tissues of healthy animals, and that they are only kept from developing by the vital influence of the bioplasm of the body. This is the view long taught by Dr. Beale.‖

Now, if the conclusions we have reached are correct, we should expect to find bacteria developing within the body in cases where the vitality of an organ, or of the whole body, is greatly diminished by injuries or disease. Some evidence on this point will now be advanced.

f. Development of bacteria in injuries and non-contagious diseases.—Burdon-Sanderson¶ was first to demonstrate that the exudation fluids of nearly all acute inflammations, including arthritis, pleuritis, and peritonitis, might contain large numbers of micrococci and bacteria, even when these inflammations were produced by agents with which no organisms were introduced. Billroth** found in fluids of an intense inflammation, produced by injection of alcohol, vast numbers of living bacteria in the rod form. Steiner and Is. Neumann†† found them equally numerous in abscesses following the hypodermic injection of carbolic acid; Ravitsch found what he believed to be *Bacillus anthracis* which developed abundantly in a liquid collection which followed the injection of a 10 per cent. solution of sulphide of ammonium with a dog;‡‡ and I have found vast numbers of streptococci in the peritoneal effusion of a rat that died three or four hours before examination from peritonitis caused by injuries in catching.

In 1875 Bergeron found micrococci and bacteria in the pus of six warm abscesses which had no connection with the air.§§ The next year Billroth‖‖ found micrococci and streptococci in four cases as follows: one abscess, one subcutaneous inflammation from crushing, and two pre-patellar inflammatory swellings in scrubbing women. Nepveu¶¶

* Lehre von der Fäulniss, p. 146, from Virchow's Archiv. B. 60, p. 453.
† Jour. Roy. Mic. Soc., 1880, p. 312.
‡ Jour. Roy. Mic. Soc., 1880, pp. 135, 312.
§ Jour. Roy. Mic. Soc., 1880, p. 135, from Jour. Prakt. Chem., xx, p. 34.
‖ The Microscope in Medicine, 1878, p. 317.
¶ Quoted by Hiller in Lehre von der Fäulniss, p. 148.
** Coccobacteria Septica, p. 87.
†† Lehre von der Fäulniss, p. 148, from Ueber die Wirkung der Carbolsäure, &c., Wien, 1870.
‡‡ Loc. cit. from Zur Lehre von der putriden Infection, Berlin, 1872, pp. 106–115.
§§ Comptes Rendus (1875), lxxx, p. 40.
‖‖ Quoted by Hiller in Lehre von der Fäulniss, p. 147.
¶¶ Quoted by Hiller, loc. cit., p. 147.

found micrococci in three internal cysts and an aneurism. Dr. Bastian * observed that there were bacteria in the fluid of a blister-bleb of a febrile patient so long as the bleb remained intact for forty-eight hours, whereas in the fluid of a blister from a healthy person no such appearances would be seen. Hiller † has examined a whole series of such collections of serum, due to friction of boots, crushing, application of cantharides, &c., and he finds that these lower organisms are nearly constant, and that they generally consist of mono- diplo-, and streptococci, and less often of bacteria filaments. Friedberger ‡ found, one day before death, in the pleural effusion of a horse suffering from pleuro-pneumonia, a considerable number of streptococci.

In regard to the development of bacteria in the blood, in cases where their pathogenic action could not be suspected, I have not been able to collect so many observations. Cunningham and Lewis § found a large number of bacteria in the blood of a dog immediately after death, from the irritating effect of liquor ammonia injected into the peritoneal cavity; and Semmer ‖ found innumerable micrococci and rods in the blood only twenty-four hours after the injection of sulphate of sepsin.

Any one in a large medical library would, undoubtedly, multiply the record of such observations, but these are sufficient for my present purpose. What I wish to insist upon is that bacteria, in the various forms, frequently exist in large numbers in the blood, and are nearly constant in local inflammatory lesions, both before and immediately after death, in cases where they could have nothing whatever to do towards producing the disease. It is not my object to offer this as a proof that bacteria do not constitute the contagion of various diseases, but rather to show that the mere discovery of bacteria in a certain lesion, or in the blood, with a particular disease, is not sufficient proof of the pathogenic action of that bacteria form. Even if filaments of a particular size are always found, this is still not proof, because with the same disease the blood may undergo a certain modification that makes it more favorable to the growth of one variety. Thus, Nägeli ¶ has shown that if spores of the different varieties of fungi are allowed to fall into a neutral solution which contains sugar, bacteria alone will multiply and cause lactic acid fermentation; but if one-half per cent. of vinous acid be added to such a solution, the sprouting fungi alone grow and cause alcoholic fermentation; while if 4 or 5 per cent. of such acid be added the molds, alone, are developed. But this is not because the bacteria will not grow in the second solution or the sprouting fungi in the third, for the bacteria will develop in a solution containing one and one-half per cent. of the acid, if they are not destroyed by the other fungi.

Again, cultivation experiments are not such reliable evidence as many seem to suppose. It is true that when the eighth or tenth generation of a cultivation proves virulent, we have ample evidence that the contagium has multiplied, but does this consist of the organism to which our attention has been directed? With *bacilli*, for instance, I have never succeeded in causing all the spores to germinate at once, and in all cultivations containing rods there would at the same time be many granules supposed to be spores. But, in such a case, can one be certain that these granules are all the spores of our particular bacillus, or even that some of them are not granules of an entirely different nature? It is

* T. R. Lewis in Quart. Jour. Mic. Sci., 1879, p. 400.
† Lehre von der Fäulniss, p. 149.
‡ Quoted by Zundel in Recueil de Méd. Vét., 1874, p. 149.
§ T. R. Lewis, in loc. cit., p. 403.
‖ Quoted by Hiller in loc. cit., p. 149.
¶ Die niederen Pilze, &c., p. 31.

evident, to any one who has practically studied the question, that many granules essentially different, such as granules of bioplasm, micrococci, &c., cannot be distinguished from spores in such cultivations. Then, as I have learned in my investigations of fowl cholera, bioplasm may have exactly the same index of refraction as the liquid in which it lives, and, hence, if it happens to be without granules it is entirely invisible under the very best microscope. Finally, in nearly all of my cultivations, when examined under the $\frac{1}{15}$th-inch Tolles objective, I have seen particles so small that their presence could barely be made out, and their nature was, of course, beyond investigation; and the same observation was made by Beale when examining contagious liquids with a one-fiftieth objective. There are, consequently, several sources of error to which we are liable, even in this method of research. An example will not be out of place. Pasteur has probably made more cultivations of fungi and bacteria than any other living man; and speaking of the choice of brewer's yeast, he says: "For this choice the microscope is the best guide, but it is insufficient. One would be wonderfully mistaken if he believed in the purity of a yeast simply because it seemed to contain no foreign matters when submitted to an examination with this instrument."*

There are still objections to the bacteria theory which it seems difficult to explain, when we consider the phenomena of many contagious diseases. Such affections do not spread with sufficient rapidity, nor leap over sufficient distances, to make it probable that they result from such organisms. Sand from the great Sahara has been carried in the atmosphere even to Rome, and South American diatoms have found their way by the same means to France; but though the spores of bacteria are much smaller, the contagium of diseases seldom leaps over a distance exceeding half a mile, and most frequently such leaps are confined to a few yards. Pleuro-pneumonia has been forty years advancing a few hundred miles in the United States; swine plague and fowl cholera may exist within the confines of a single township for a whole year and not pass beyond, and the same is true of anthrax. How different with a disease demonstrably due to even the larger spores of fungi, like the coffee-leaf disease of Ceylon! This was first seen at Madulsima in 1869, and showed itself at widely separated points, and over considerable areas the two following years. It speedily found its way to Southern India, and in 1876 appeared in Sumatra, and in 1879 in Java, Bencoolen, and Fiji.†

Again, thorough ventilation of infected apartments very often frees them of contagion in the course of a few weeks, while bacteria germs are perhaps the most indestructible of all living things, resisting alike the most intense cold and a temperature superior to boiling water. The various forms of bacteria, also, abound in all inhabitated parts of the world, but many contagious dieases, particularly of animals, are confined to certain countries and never exist elsewhere, unless by direct importation of virus; and there is now good reason to believe that the greater part of these maladies never occur, except as produced by virus originating in the body of an affected animal. But if the bacteria theory were true and especially the form advocated by Nägeli, we should expect to find spontaneous cases continually occurring.

These points are not mentioned, however, as insuperable objections—they should not discourage us in our investigation of the bacteria theory, but they should warn us against carrying this theory to extremes,

* Études sur la Bière, &c., p. 227.
† Quart. Jour. Mic. Sci., April, 1880.

in the present state of our knowledge, and convince us that such a theory is not to be accepted because of a few superficial observations. I am led to these remarks because it is quite the fashion in this country, even among scientific men, to accept every discovery of a bacterium in the blood of an animal or man, that had died of a contagious disease, as a demonstration of the pathogenic action of that organism, no matter how long a time elapsed between the death and the microscopic examination, or how few precautions were observed to prevent the admission of atmospheric germs.

To establish this theory, an unmistakable connection must be demonstrated between the bacteria found and the contagium of the disease. If the virus is destroyed by certain extremes of temperature, the bacteria must be ki led at exactly the same point; if the bacteria are destroyed by a solution containing a certain proportion of a given antiseptic, the activity of the virus must disappear under the same circumstances. Both must be overcome at precisely the same degree of putrefaction, and throughout every condition of life there must be a perfect correspondence.

Finally, when the contagium of a certain disease has been decided to be identical with a peculiar bacterium, while this makes the general theory more probable, we cannot accept it at once as a proof that other contagia consist of bacteria, since the qualities of the virus of different diseases varies to such an extent as to make it probable that they are of essentially different natures. This difference may, it is true, be owing to the different powers of distinct varieties of these organisms, but it would be exceedingly unscientific to accept this as a fact without demonstration.

II.—THE CONTAGIUM OF ANTHRAX.

As I have already stated in my report on the Southern Cattle Fever, the connection between the survival of the *Bacillus anthracis* by the production of spores and the retention of activity in the virus of anthrax so exactly correspond and may be so clearly demonstrated, that it is no longer possible to doubt the pathogenic action of this *Bacillus*.

The interest in this organism is so great and the importance of knowing the stages of development of *Bacilli* so evident, that I have reproduced drawings showing the spore formation, the appearance of the spores after the disintegration of the rods, and the germination of the spores according to Toussaint, Ewart, and Cohn. Toussaint's figures are excellent, but they appear to be magnified about twice the number of diameters indicated in the description. In the blood, during life, the organism exists in the form of rods alone, like those shown at *d* and *e*, Fig. 25, and spores are only exceptionally formed before death in local inflammatory lesions where the vitality of the tissues has been overcome. After death, however, or in suitable cultivation liquids, with a proper temperature and access of air, the filaments lengthen and form spores as in Fig. 22; the spores are afterwards freed by disin'egration of the filaments, and become isolated as in Fig. 24, but they do not form zoogloea masses or present the appearance of division by fission, as is the case with micrococci. Ewart believes that the spore may divide into four sporules before germinating, as shown in Fig. 26, but his observations are so different from those of other equally competent investigators, that they require confirmation. The production of sporangial forms, Fig. 23, by cultivation in the serum of dog's blood, as observed by Toussaint, is a very interesting fact, and suggests that Hallier may not be so far from the truth, after all, in supposing that these organisms arise from the higher forms of fungi, and may develop into such again if cultivated

under suitable conditions. So far all observations confirm the discoveries of Koch, that, when spore formation is prevented, the activity of the virus disappears with the death of the filaments; and that after spores have formed, the virus is not destroyed by cold, deprivation of oxygen, putrefaction, dilution, &c.; that, in other words, the condition of existence of the *Bacillus* and of the virus are identical.

During the last year a number of observations have been made which advance our knowledge very considerably in regard to this particular organism. Professor Greenfield* has shown that by cultivating the *Bacillus* in aqueous humor, its activity as a virus decreases with each generation, and that in no case were any symptoms or a fatal result produced by inoculation with a later generation than the twelfth. The cultivations were continued to the nineteenth generation, each successive generation presenting identical morphological characters at the various stages of its growth, and showing no diminution in the capacity for growth, nor marked variation in the time and temperature relations of its germination.

Colin,† while investigating the characters of malignant pustule caused by inoculating dogs with anthrax fluids, found that in many cases the pustule loses its virulence and the serum from it no longer produces the disease in rabbits. In three cases these fluids still contained the *Bacillus*, and granules having the character of its spores, but they no longer produced anthrax.

Another most interesting observation was made by Feltz‡, who found in the blood of a puerperal-fever patient, two days before death, bacteria filaments, the nature of which he investigated and found that they multiplied in the rabbit. Corresponding with Pasteur, he was convinced by this gentleman that his new leptothrix was the *Bacillus anthracis*.§

These facts would seem to indicate that Nägeli's views in regard to the pathogenic bacteria are correct; for here we have two cases in which a pathogenic form loses its virulence though it does not cease to exist, and another case in which it may be at least suspected that a septic bacterium has been transformed into a pathogenic one. At least it seems difficult to explain the presence of this parasite in puerperal fever on any other hypothesis.

Chauveau, Toussaint, Pasteur, and Greenfield have all published experiments to show that one attack preserves from a second. A mitigated form of virus is obtained by Toussaint by heating for ten minutes to 55° C., and the same result is reached by Greenfield by successive cultivations in aqueous humor.

Pasteur‖ has demonstrated that the spores are carried to the surface by earth-worms, even when animals are buried at a considerable depth, and that these may produce anthrax in animals pasturing over such grounds. Only a few yards from such infected spots, however, sheep were pastured with impunity. In an outbreak of anthrax near Nancy, Tisserand and Poincaré suspected the water which moistened the pasture to be the bearer of the contagion. It was found to contain *Bacilli* similar to those in the blood of the dead animals, and when inoculated hypodermically on a guinea-pig caused death in three days; a second, inoculated with the blood of the first, died in two days of

* Jour. Roy. Mic. Soc., 1880, p. 839; Proc. Roy. Soc., xxx, p. 557
† Bul. de l'Acad. de Med., 1880, p. 657.
‡ Jour. Roy. Mis., Soc. 1879, p. 454, from Comptes Rendus, 88. p. 610.
§ Jour. Roy. Mis. Soc., 1879, p. 928, from loc. cit., 88, p. 1214.
‖ Comptes Rendus, xci (1880), p. 86.

charbon.* Chauveau† has demonstrated that Algerian sheep do not readily contract charbon; that this immunity is inherited, and that the resistance to the disease may be overcome by increasing the amount of virus used in the inoculation when the animals contract the disease.

III.—THE CONTAGIUM OF SEPTICÆMIA.

Two widely different views have long been maintained in regard to the nature of the septicæmic poison. The first is based upon the experiments of Panum, Bergmann, Zülzer, Hiller, &c., in Germany; Davaine (1864) and Robin in France, and Richardson and Cunningham and Lewis in England; by these investigations it has been shown that putrid blood, &c., may be boiled for even eleven hours without destroying its poisonous properties, that this poison may be made to combine with acids and form definite chemical compounds; that there is no period of incubation to the disease produced. These experiments are certainly definite enough to carry conviction, and to allow of clear conclusions being drawn from them; but it is equally evident that they apply only to a certain definite condition, and that their influence on the theory of contagion must be very limited. Nevertheless, these experiments have been cited, no longer ago than July, 1879, by Dr. Lewis as evidence that septicæmia is not the result of a living virus;‡ and for this reason it has seemed best to devote a few paragraphs to the subject in this place.

In 1874, Colin§ demonstrated that there was a wide difference in the appearance and effects of putrid and septicæmic blood. The former had a fetid odor and the globules were no longer intact; the latter presented no evidence of putrefaction, and the globules were in perfect condition; the former only acted in large dose and in an uncertain manner, failing in three-fourths, or sometimes in nine-tenths, of the cases; the latter was certain in its action even in an infinitesimal dose; the former produces, at times, septicæmia, but often a peculiar poisoning; the latter constantly causes septicæmia. The difference in the symptoms of septicæmia and the septic poisoning was very marked; the former had a period of incubation, and the effect produced was independent of the amount of virus inoculated; the latter is produced immediately after absorption of the poison, and the effect is in proportion to the quantity absorbed. Davaine‖ had shown in 1864 that the effects of putrefied substances do not go beyond the animal into which they are inoculated, and that the toxic agent of such substances cannot reproduce itself. In 1878, Koch confirmed these conclusions by his investigations with mice; he found that when these animals were inoculated with five drops of decomposing blood they die in from four to eight hours, but their blood does not communicate disease to others; but when inoculated with one-twentieth of a drop to one drop, many remain well, but others die in from forty to sixty hours, and the blood and tissue juices of these convey a disease, even when inoculated in small quantity. The former disease was sepsin poisoning; the latter was septicæmia.¶

In regard to the nature of the virulent agent in true septicæmia, there is still a difference of opinion. Hiller believes it to be an intese chem-

*Comptes Rendus, xci (1881), p. 179. †Comptes Rendus, xci (1880), pp. 33, 1396, 1526.
‡Microphytes of the Blood, &c., Quart. Jour Mic. Sci., 1879, p. 403.
§Recueil de Méd. Vét., 1874, pp. 361 and 687.
‖Comptes Rendus, lvii, 1864, pp. 230 and 386, quoted in Les Bactéries, p. 128.
¶Untersuchungen über die Aetiologie der Wundinfectionskrankheiten, Leipzig, 1878.

ical poison.* Pasteur maintains that it is identical with his septic vibrio, which consists of moving filaments of various lengths, some of which may surpass the field of the microscope, but which may exist in the form of very small lenticular bodies or even as extremely short and thin rods.† Toussaint considers the disease and parasite to be identical with chicken cholera and its granules.‡ Orth, Klebs, and Birsh Hirschfeld believe the disease to be due to micrococci, and the latter does not admit the presence of any other parasite.§ Koch found *Bacilli* one micromillimeter long ($\frac{1}{25000}$th of an inch) in the septicæmia of mice, and in the septicæmia of rabbits oval micrococci 0.8 to 1 micromillimeter in diameter.‖

With these widely different views as to the nature of the septicæmic poison, we cannot at present come to a satisfactory conclusion; but of one thing we are assured, and that is of the extremely small size of the particles which constitute the virus. Davaine has shown that the activity of the virus increases with each generation, until with the twenty-fifth generation one-trillionth of a drop constantly produces the disease in rabbits. There must, consequently, be at least one trillion separate particles in a drop of blood, and probably many more, or they could not be so thoroughly distributed in the dilution of this as to have each drop of the resulting mixture become virulent. But if we take this number for our consideration, we find it so large as to make it seem impossible that the micrococci of Koch can be the cause of the disease, unless they exist also in a form very much more minute, for an average drop would not exceed fifty cubic millimeters in capacity, or fifty billion cubic micromillimeters, and two of the micrococci would equal one cubic micromillimeter; hence, a drop could only contain one hundred billion of these micrococci if packed solidly with them, which is far from being the case even when we include the blood corpuscles. But this number is ten times too small, and if we consider that there should be *more* than one trillion particles, and that the blood drops only contain a small part of their capacity of micrococci, it seems impossible to accept these as the only cause of the disease.¶

IV.—THE CONTAGIUM OF FOWL CHOLERA.

Toussaint and Pasteur succeeded in cultivating the granules of this disease. The latter found it to develop with extraordinary rapidity in an infusion of chicken muscle, neutralized with potash and sterilized by a heat of 110° to 115° C. Although the most diverse micro-organisms, including the *Bacillus anthracis*, grow readily in yeast water (*i. e.*, decoction of beer yeast, filtered and sterilized by heat), the microbe of chicken cholera not only does not multiply in it but perishes in less than forty-eight hours.** This suggests that there is a wide difference between the granules of fowl cholera and any form of bacteria, and it indirectly confirms the view that the contagia of different diseases may be of widely different origin and nature. I have cultivated the granules up to this time in infusion of chicken muscle alone, and I find that they form an exceedingly delicate membrane (petalococcus of Billroth) on the surface of the liquid after the manner of bacteria, and that this

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* Lehre von der Fäulniss, p. 167.
† La Theorie des Germes, Recueil de Méd. Vét., 1878, p. 513.
‡ Comptes Rendus, xci (1880), 301 to 303.
§ Referred to by Mégnin in Les Bactéries, p. 133.
‖ Jour. Roy. Mic. Soc. 1879, p. 755.
¶ This calculation is modified from one by Hiller in Lehre v. d. Fäulniss, 167.
** Bul. de l'Acad. de Méd., 1880, pp. 121 to 134.

membrane is made up of the granules having the same appearance as in the blood.

My observations that the blood in this disease contains few if any free granules immediately after being drawn from the vein during life, and that these apparently wander from the nuclei and leucocytes in the same manner as the former wander from the red corpuscles, is still further evidence that they may be granules of animal protoplasm instead of being of a vegetable nature.

Toussaint* says: "Two animals of the same species inoculated with blood from chicken cholera and acute septicæmia present the same symptoms, die in the same time, and have exactly the same lesions. The parasite in each case is the same." He has produced exactly the lesions of cholera by feeding blood, &c., of septicæmic animals.

On the other hand, Pasteur, who has studied both diseases for a long time, says: "I am not in accord with M. Toussaint in regard to the identity which he affirms to exist between acute septicæmia and the cholera of fowls. These two diseases are entirely different."†

The virus, according to Toussaint, kills rabbits in twelve to fifteen hours, and injected under the skin of the horse, ass, dog, and sheep causes formation of a tumor, which is resolved into an abscess with very grave general symptoms, but without the blood becoming virulent.

Pasteur finds that guinea pigs are not killed by such inoculations as certainly as fowls, but that the formation of an abscess is often the only result. This would seem to oppose the idea of its being identical with septicæmia, since guinea pigs are extremely sensitive to this virus.

The same gentleman has succeeded in obtaining a mitigated form of the virus by allowing his cultivations of the granules in infusion of chicken muscle to stand three to eight months in contact with atmospheric oxygen. In successive cultivations made within a few days of each other there was no dimunition of the virulence after an indefinite number of generations; but when a cultivation was allowed to stand several months before another generation was started, the virulence was found to be remarkably diminished, and this diminution might be carried to any point desired, up to the death of the granules. Now, if this attenuated virus is cultivated with short intervals between the generations, it is found to remain in its mitigated condition; and if the intervals between the generations are increased, it perishes at a point which a more active virus would survive. Finally, Pasteur has proved that this attenuation is caused by exposure to the oxygen of the atmosphere, for if the cultivations are made in sealed tubes nearly filled with the cultivation liquid, the oxygen is exhausted by the growth of the microbe, and, being no longer subjected to its influence, the virulence is retained an indefinite time in its original condition.‡

All observations, then, point to these granules as the active agents of the disease, but as to their exact nature and origin there is still reason for doubt.

V.—THE CONTAGIUM OF SWINE PLAGUE.

In regard to the parasite of swine plague, or, more correctly speaking, the form of organism found in the virus, there is far from being the same unanimity of opinion. Dr. Klein§ and Dr. Detmers‖ believe it to be

*Comptes Rendus, xci (1880), p. 301.
†Comptes Rendus, xci (1880), p. 457.
‡Comptes Rendus xci (1880), pp. 673 to 680.
§Quart. Jour. Mic. Sci., April, 1878.
‖Report of Department of Agriculture, 1878, also, contagious diseases of swine and other animals. Department of Agriculture, 1880.

a *Bacillus*, while Méguin* and myself† have found granules which form clusters and chains but not rods. Klein found in the virus granules which he at first took for micrococci, and only after a number of cultivations succeeded in obtaining what he believed to be a pure crop of *Bacilli;* inoculations with this cultivated virus are said to have produced the disease, but unfortunately the number of animals inoculated or the symptons or *post-mortem* appearances of the affected ones have not been made public. The *Bacilli* are described as growing to long rods, with a swarming stage, rapid multiplication by division, growth into long apparently smooth filaments, and, with sufficient access of air, the formation of bright cylindrical spores.

Now, in view of the other investigations noted, it would be interesting to know if the granules observed in the virus were cylindrical, and if in the cultivations the whole or any considerable part of these existed at any one time in the condition of filaments. Méguin and the writer have found only spherical granules in the virus, and Detmers speaks of the granules as globular and figures them by small circles; hence the pertinent question, were the original granules observed by Klein spherical or cylindrical? Figs. 20 and 21 show the granules observed by Méguin in the blood and bronchial mucus, and it is evident the organism there figured is identical with the one observed by me.

Again, Dr. Klein could not have found *Bacilli* filaments in the virus, or he would not have considered the organism at first as a micrococcus; Dr. Detmers maintains that the rods exist in the blood and tissues even during life; while blood which I obtained by breaking capillary tubes within the blood-vessels and immediately sealing, and which consequently was not exposed to the air at all, developed chains of spherical granules alone and never *Bacilli.* Even when such virus was cultivated on slides with access of air in aqueous humor, white of egg and urine, I have only obtained the granules singly in clusters and chains. Dr. Detmers has not, as I understand, taken any precautions to prevent access of atmospheric germs, and in most cases his observations seem to have been made some hours after death; hence, it is at least possible that the *Bacilli* filaments found in the blood and exudation liquids developed from septic germs admitted from the air, or even from such germs contained in these liquids before death.

Dr. Klein states that his *Bacillus* had the same stages of growth as the *Bacillus subtilis*, and consequently as the *Bacillus anthracis*, and like it requires the admission of oxygen to enable it to form spores. Now, the *Bacillus anthracis* only exists in the blood as filaments during the life of the animal, and only forms spores after the death of the host. It is the filaments, not the spores, that develop in the blood, block up the capillaries, and by their vital activity cause the formation of poisonous matters, which completes their pathogenic influence. It is difficult to see how such comparatively dormant bodies as spores can have any influence on the health of animals, or even how they can reproduce themselves in the fluids of the body if these do not contain filaments as well.

We are, consequently, forced back upon the observations of Dr. Detmers, who has found filaments as well as granules; but these granules, at least, do not correspond with those of Dr. Klein, since they are globular instead of cylindrical, form zoogloea masses, and multiply by fission; nor do the filaments of Detmers form cylindrical spores. It would seem,

*Recueil de Méd. Vét., 1880, pp. 36 and 37.
†Part I of this report.

therefore, that the observations of this gentleman do not confirm those of Klein any more than they do those of Méguin and myself. In each case there is an important discrepancy.

There are only four suppositions which I can admit in explanation of this variation of observation, considering that in each of three outbreaks in different sections studied by me I constantly found the same organism: 1. The diseases studied by Klein, Detmers, and myself may not have been identical. 2. The same organism may assume different forms under different conditions. 3. The filaments of Klein and Detmers may have developed from septic spores different in nature, but resembling the pathogenic granules. 4. The virus may consist of transparent bioplasm or of granules so small as to have escaped the attention of all observers. The first supposition is doubtful because of the similarity of symptoms and lesions; the second and fourth are more probable but still doubtful; the third I must at present regard as most probable, for reasons to be given immediately.

In the outbreaks of swine plague studied by me in 1878, there were frequently found gangrenous patches of the skin and intestines, and the animals had a plain odor of putrefaction even before death; and this could only occur from one cause, viz., the multiplication of the septic bacteria in the gangrenous parts, probably in the exudation liquids as well, and possibly also in the blood. At any rate, within an hour or two after death, these animals had such an extremely offensive odor as to make it nearly certain that a microscopic examination would have revealed not only micrococci but *Bacilli* and *Vibrios;* at least, I have almost always found these different organisms in liquids studied by me during the last year, which had reached a similar state of decomposition.

In the disease as studied by me during the present year, however, these phenomena were not present; the attacks were mild; there were no gangrenous patches and no offensive odor; several of the animals would have recovered, and there was no reason to believe that any multiplication of septic bacteria had occurred. The blood of these was gathered at slaughter, sealed in glass tubes without coming in contact with the air, and those germs which existed in the blood, and no others, had an opportunity to develop.

Finally, I have made microscopic sections of the lung, ulcerated intestine, and papules of skin. In some cases the tissues were fresh and cut by means of the freezing microtome; at other times they were preserved in glycerine, chromic-acid solution, or alcohol; the sections have been examined in the natural condition, and also stained with carmine, hæmatoxylon, or aniline violet. I have particularly used the method recommended by Eberth*, by which he demonstrated *Bacilli* in the liver of a badger. It consists in placing thin sections in a tolerably strong solution of methyl violet for one to six hours, then washing in water containing one-half per cent. of strong acetic acid, in which they remained from one to four hours, until no more coloring matter was dissolved out. The sections are then placed in alcohol, which removes still more of the coloring matter, and they are then either mounted in glycerine or clarified with oil of cloves and mounted in balsam. By this treatment the tissues remain nearly colorless, while the nuclei and bacteria, if any exist, retain the coloring matter. In none of these sections have I been able to demonstrate the presence of *Bacilli*.

Virus sent me by Dr. Detmers in a liquid form still contained many such *Bacilli* as he has described, and also a considerable number of

* Journal of Roy. Mic. Soc., 1880, p. 133.

both oval and spherical particles, which I considered as bacteria spores. But inoculation proved that this liquid was no longer a virus, that it had lost its activity by putrefaction, though the septic rods supposed to be peculiar to the virus were still retained, and by their active movements demonstrated their vitality. Again, cotton saturated with pleural effusion and dried by the same gentleman was placed in a clean beaker and moistened with distilled water; in less than an hour this water swarmed with *Bacilli* of the same dimensions, viz., about one thirty-five thousandth of an inch in diameter, and from one eight thousandth of an inch to several times this in length. There were also oval bacteria spores and globular bacteria in both clusters (zoogl[oe]a) and chains, as well as singly. In this case there was no odor of putrefaction. Still, three cubic centimeters, injected hypodermically, did not in the least affect the health of the animal.

The only conclusion I care to draw from these experiments is that the *Bacilli* and globular micrococci described as peculiar to swine plague exist as well in decomposing liquids, and may be injected in vast number without producing the disease. Indeed, rods of the dimensions given are frequently found in the human mouth.

There is one other objection to the view that the granules of the blood in this disease are *Bacillus* germs or spores. All observers agree that such spores are indestructible by prolonged drying, putrefaction, or other natural agencies; the spores of *Bacillus anthracis* resist such conditions for years; but putrefaction destroys the virus of swine plague in a few days, and virus dried before such granules could have possibly germinated to rods may lose its activity as soon, and generally does in a few months.

In his last report, Dr. Detmers* thinks he may have misnamed his bacterium in calling it the *Bacillus suis*, because (1) in the germ or globular form it developes in zoogl[oe]a clusters, and because (2) it undergoes a change from the globular to the rod shape—characteristics not recognized in regard to the genus *Bacillus*. I see no reason to doubt, however, that the rods are *Bacilli*, for the characteristics of this genus, as given by Cohn,† in 1875, and very recently by Luerssen,‡ do not include the method of reproduction. It is not admitted by Cohn that bacteria rods of any kind (except *Bacterium termo*, which can scarcely be considered as rods) form zoogl[oe]a masses, though Ray Lankester and Klein believe they have observed such forms with certain varieties of *Spirillum*, § and Prazmowski has observed the same with *Bacillus amylobacter.* || What is more to the point, it is not admitted by the best authorities that *Bacilli* have any other vegetation forms than spore, rod, and filament. The spores of this genus have never been observed to multiply by fission and form zoogl[oe]a clusters, but always to germinate into rods either immediately, as maintained by Cohn, Koch, and Toussaint, or after division into four sporules, as believed by Ewart.

The fact, then, that Dr. Detmers's globules multiply by fission and form gliacoccus clusters, as was the case with those I observed, is not evidence to me that the organism seen by him is entirely different from any other bacteria form yet discovered, but it seems more reasonable to believe that the globules and rods are distinct organisms, and that the

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* The Contagious Diseases of Swine and Other Animals, Département of Agriculture, 1880, p. 60.

† Beiträge zur Biologie der Pflanzen, B. I. H. III, p. 203.

‡ Quoted in Journal Roy. Mic. Soc., 1880, p. 837.

§ Méguin, Les Bactéries, p. 33.

|| Journal Roy. Mic. Soc., 1879, p. 927.

particular granule which he saw develop into a rod was different from those granules which form gliacocci. To watch the germination and development of a spore into a rod is a more delicate and difficult matter than is generally supposed. Some of our best microscopists have spent hours and days watching such germs without being able to satisfy themselves that they germinate;* and it would not be very remarkable if a mistake had been made in such an observation.

If we add to this reasoning the fact that in a very considerable number of cultivations, made with great care, I was never able to obtain rods from the granules which I found in the virus, it seems to me the probabilities are entirely against the view that they are *Bacillus* germs, or that they develop into a rod form.

These are the results of my investigations of the virus of swine plague. I had hoped by cultivation experiments to prove that the granules observed either were the cause of the disease or that they are an epiphenomenon; but owing to the fact that the virus in every case lost its activity after the first generation, or became too mild to afford satisfactory results, such evidence could not be obtained. It was impossible for me to carry the virus beyond a second generation, even by inoculating on pigs that had never before been exposed to the contagium.

If, in conclusion, we admit the presence of a particular bacteria form in the effusions, or even in the blood, in this disease, the facts already referred to in regard to the presence of such organisms in non-contagious maladies, often before death, renders it necessary that a connection be established between such bacteria and the contagium; and certainly no satisfactory connection or identity has been shown to exist between the bacteria and virus in this disease up to the present time.

PART IV.—INFLUENCE OF RECENT INVESTIGATIONS ON OUR MEANS OF PREVENTING CONTAGIOUS DISEASES.

Medical treatment.—Although Davaine† has recently proved that a solution of iodine containing but one seventy thousanth part of this substance was sufficiently strong to destroy the virus of anthrax, it has not succeeded so well in the treatment of the affection as this fact had led us to expect. There has, consequently, been little real advance in the medical treatment of this class of diseases.

Vaccination.—At present the attention of investigators is still turned for the most part to methods of prevention, and chief among these is inoculation by means of a mitigated virus. This has been obtained in the case of anthrax by two methods; that of Toussaint, which consists in heating the virus to a temperature of 55° C. for ten minutes, and that of Greenfield, by successive cultivations in aqueous humor.

Pasteur has obtained a similar form of virus for fowl cholera by allowing cultivations of the ordinary virus to remain in contact with the air for a number of months before starting a new generation.

The advisability of using such a virus can only be determined by an extended series of experiments, for objections of considerable weight might develop themselves in practice. The fact that the disease is communicated by the digestive tract would favor the process of inoculation, for it would only be necessary to mix the virus with the food, and thus inoculate by wholesale.

* Dr. T. R. Lewis, Quart. Jour. Mic. Sci., 1879, p. 389.
† Bul. Acad. de Méd., 1880, p. 757.

Breeding from insusceptible animals.—Chauveau* has shown that the insusceptibility of Algerian sheep to charbon is an inherited power, and he proposes to confer this upon other breeds by crossing. Of course, the practicability of this is yet to be tested, but the idea is one worthy of careful consideration. But if insusceptibility to charbon is inherited by a certain breed of sheep, may not fowls insusceptible to cholera be capable of conferring the same power of resistance upon their offspring? I have found that a very considerable proportion of fowls are capable of resisting repeated inoculations with very active virus, some showing only the mildest symptoms of the disease, and others remaining entirely free from any appreciable results, either in general health or at the point of inoculation. It would be a matter of the very greatest importance to breed from such birds, and then determine the proportion insusceptible among their progeny. It is possible that this might prove the most practicable method of dealing with this destructive epizoötic.

Prevention of fowl cholera.—This disease can only be introduced on a place by direct importation of the virus, either with fowls, or by birds, rabbits, or insects carrying it from neighboring farms. An outbreak is generally caused by fowls from infected premises being added to the flock. The virus is never carried through the atmosphere.

When more than one fowl dies within a short time, cholera should be suspected, and a careful investigation of the case made. If the urates of the excrement are stained yellow or yellowish green, especially if there is diarrhea with excrement of this color; if the liver is enlarged, and the birds sleep most of the time before death, no time should be lost in adopting measures to check the disease.

For this purpose, the fowls should be separated as much as possible, and given restricted quarters where they may be observed, and where disinfectants can be freely used. As soon as the peculiar diarrhea is noticed with any of the fowls, the birds of that lot should be changed to fresh ground, and the sick ones killed. The infected excrement should be carefully scraped up and burned, and the inclosure in which it has been thoroughly disinfected with a one-half per cent. solution of sulphuric acid, or a one per cent. solution of carbolic acid, which may be applied with an ordinary watering-pot.

Dead birds should be burned, or deeply buried at a distance from the grounds frequented by the fowls.

The germs of the disease are taken into the system only by the mouth, and for this reason the watering troughs and feeding places must be kept thoroughly free from them by frequent disinfection with one of the solutions mentioned.

Sulphuric acid is very much the cheaper disinfectant, and is equally efficient with carbolic acid, even in solutions of half the strength; indeed, so far as expense is concerned, it would seem impossible to find a disinfectant that will compare with the sulphuric acid solution.† The one objection to recommending the indiscriminate use of sulphuric acid as a disinfectant is its great corrosive powers when in the concentrated form, which makes it unsafe for those not acquainted with its nature to handle it. The same is true to a less extent of carbolic acid, however, and it is possible that dealers could furnish a sufficiently diluted solution of the former to be handled with safety, and still at a price very much below other disinfectants, or that plain directions for use accompanying each package would render even the commercial acid safe in the hands of the great majority of people.

* Comptes Rendus, xci (1880), p. 33.
† This solution was first recommended by M. Pasteur.

Three weeks after the last case of sickness, the fowls may be again placed together in a disinfected run, or in one where the sick birds had not been admitted. They should be kept here under observation for at least two or three months before being allowed to roam over grounds that had been infected by the discharges of those affected with the disease.

If the disease breaks out afresh, it is evidence that the disinfection has not been thorough, or that the fowls have gained access to infected places that have not been treated with the solutions. My experiments demonstrate beyond a doubt that either of the solutions mentioned destroys the virus of the disease in a few minutes; and as there is no reason to believe that the disease ever originates except from the introduction of virus produced in the body of a previously sick bird, we have here a reliable means of freeing any farm or any section of the country from the ravages of this fatal plague.

The one doubt that still remains is in regard to the time that the virus may exist in open grounds where disinfection is difficult if not impossible, owing to the extent of surface to be gone over. Whether such grounds are safe after a few months, or whether this time must be extended to a year or more, it is impossible at present to say. Until this point is decided by direct experiment, however, the only safe plan is to keep the fowls in a restricted run, which has been previously well disinfected, and not to allow them on infected grounds for a year or more after the infection has occurred.

As the disinfecting solution may be made by adding one pound of sulphuric acid to twenty-four gallons of water, or one ounce of acid to six quarts of water, and as the acid costs but 15 to 20 cents per pound at retail and only 3 to 6 cents at wholesale, the expense of disinfecting a very considerable space would be slight.

Medical treatment.—Treatment of sick birds is not to be recommended under any circumstances. The malady runs its course, as a rule, in one, two, or three days, and it can only be checked with great difficulty. As the appetite is very poor, medicine can only be administered regularly by taking each bird by itself and forcing it to swallow. But this requires too much time to make it advisable, if there were no other objection to the practice. Even in those cases in which I have succeeded in prolonging the life for two to three weeks death has finally occurred from profound changes in the liver and intestines. The great reason, however, for not treating sick birds is that the excrement is probably filled with the contagion, and it is much better to destroy them at the start than to keep them to multiply the contagious germs and infect the grounds and remaining fowls.

The only preventive treatment needed is the disinfection and isolation already described at length.

Respectfully submitted.

D. E. SALMON, D. V. M.

ASHEVILLE, N. C., *December* 1, 1880.

APPENDIX TO DR. SALMON'S REPORT.

RECORD OF EXPERIMENTS NOT DETAILED IN BODY OF REPORT.

Experiments to determine the effect of solutions of chloride of zinc on the virus of swine plague Inoculations, January 3, 1880.

PIG NO. 1.—*Inoculated with pure virus.*

Date.	Hour.	Atmospheric temperature.	Body temperature.	Remarks.
1880.	*A. M.*	° *F.*	° *F.*	
Jan. 5	8.30	43	102¾	
6	9.00	60	102½	
7	10.00	58	103¼	Two small pieces of dried inflamed lung, introduced hypodermically.
8	8.00	53	103	Coughs.
9	9.00	50	103	
10	8.30	52	102½	
12	8.15	60	102	Has eruption.
13	9.30	34	101¾	Eruption much plainer.
14	8.30	28	100¾	
15	9.15	32	101	
16	9.00	32	102	
17	10.30	....	102½	Coughs very much.
20	....	....	101¾	

This animal was kept till January 31, and was then killed by bleeding. It had improved slightly during the last few days.

Post-mortem examination.—Skin: The eruption still very plain, and consists of papules flat on summit and one-third inch in diameter and less.

Areolar tissue: Has several deposits of dark pigment.

Digestive organs: No lesions except adhesions of large intestines by inflammatory new formations. *Parasites:* In large intestine, considerable number of *Tricocephalus crenatus;* in small intestine, very many of the *Echinorhynchus gigas* from 12 to 18 inches in length.

Kidneys: These organs were normal, but the tissues about them were thickened, hardened, and completely filled with the worm known as *Stephanurus dentatus.*

Lungs: In color nearly normal, but large portions did not collapse and give a hard, solid sensation to the touch. Bronchi filled with white froth, with considerable thick tenacious mucus; following the ramifications of these, a small number of the *Strongylus elongatus* or lung worm were found; some were even in the smallest tubes that could be traced.

Microscopic examination of contents of bronchi: This was found to consist of large granular leucocytes, with a few small ones, a considerable amount of *débris* from the mucous membrane lining these passages; some bodies resembling the torula form of fungi, and vast numbers of small spherical granules, *i. e.*, micrococci.

This pig had been affected with the most troublesome cough of any in this series of experiments; the eruption had also been among the plainest, and it was a surprise to find so few of the ordinary lesions of swine plague.

PIG No. 2.—*Inoculated with pure virus diluted with four parts distilled water, January 3, 1880.*

Date.	Hour.	Atmospheric temperature.	Body temperature.	Remarks.
1880.	*A. M.*	° *F.*	° *F.*	
Jan. 5	8.30	43	102⅛	
6	9	60	103	
7	10	58	104	
8	8	53	102¾	
9	9	50	104¾	
10	8.30	52	103¼	
12	8.15	60	102¾	
13	9.30	34	103¼	
14	8.30	28	103	
15	9.15	32	102½	Has eruption.
16	9	32	102½	
17	10.30	....	102	
20	....	....	102½	

But for the eruption, which was very plain, it would have been impossible to have detected the disease in this animal. She was preserved and afterwards used in other experiments.

PIG No. 3.—*Inoculated with virus that had been mixed one-half hour before using with four parts of solution of chloride of zinc 1 to 500.*

Date.	Hour.	Atmospheric temperature.	Body temperature.	Remarks.
1880.	*A. M.*	° *F.*	° *F.*	
Jan. 5	8.30	43	102¼	Inoculated January 3.
6	9	60	102	
7	10	58	103¼	
8	8	53	103¾	
9	9	50	104¾	
10	8.[illegible]	52	103¼	
12	8.15	60	102¾	
13	9.30	34	102¾	
14	8.30	28	101½	
15	9.15	32	100¾	Has eruption.
16	9	32	102¼	
17	10.30	....	102	Coughs.
20	....	....	100¼	

The disease was so mild that the animal was preserved for future experiments.

PIG No. 4.—*Inoculated with virus that had been mixed one-half hour before using with four parts of solution of chloride of zinc 1 to 1000.*

Date.	Hour.	Atmospheric temperature.	Body temperature.	Remarks.
1880.	*A. M.*	° *F.*	° *F.*	
Jan. 5	8.30	43	103¾	Inoculated January 3.
6	9	60	104¼	
7	10	58	105	
8	8	53	102½	
9	9	50	101½	
10	8.30	52	104½	
12	8.15	60	104¼	Coughing.
13	9.30	34	10[illegible]¾	
14	8.30	28	103½	
15	9.15	32	104½	Has eruption. Vast increase of leucocytes and granules in blood.
16	9	32	103¾	
17	10.30	....	103¾	Covered with eruption.

Killed by bleeding at 2 p. m., January 17.

This animal had never appeared quite well; she did not thrive, and was dull and languid. Her appetite was always good, but she had a chronic affection of the skin, and had lost flesh rapidly for the few last days. Although inoculated with virus, treated with chloride of zinc solution of 1 : 1000, which made a cloudy mixture by coagulation as soon as the contagious effusion touched it, she was one of the first to present symptoms of the disease (cough and eruption).

Post-mortem examination.—Skin: Covered with papules, particularly plain on inside of thighs, over the belly, and between the fore-legs.

Areolar tissue: A number of deposits, an inch or more in diameter, of a dark bluish pigment, were found in the subcutaneous tissue; it was most abundant about the mammary glands.

Digestive organs: Were closely united, and the mesentery much thickened, as the result of inflammation. The newly-formed tissue about the intestines contained considerable numbers of the *Stephanurus dentatus*, or lard worm. The large intestine showed no trace of thickening, ulceration, nor even of congestion; the small intestines were blocked completely, as it seemed, with large numbers of the *Ascaris suilla*, from ten inches to one foot in length; there were also many of the *Echinorhynchus gigas* a foot or more long. The duodenum was the seat of a few elevations one-eighth inch in diameter, and having a red, inflamed appearance. The mucous membrane of the stomach had a patch two or three inches in diameter, corresponding to the greater curvature, of a deep red hue, and evidently the result of congestion.

Liver: Somewhat congested and softened.

Spleen: Had a deep red border, and was mottled over its surface.

Lungs: The greater part of the tissue hepatized, and many of the bronchial tubes entirely blocked with lung worms (*Strongylus elongatus*). Bronchi filled with white froth.

Hyperæmia of nearly all the *lymphatic glands.*

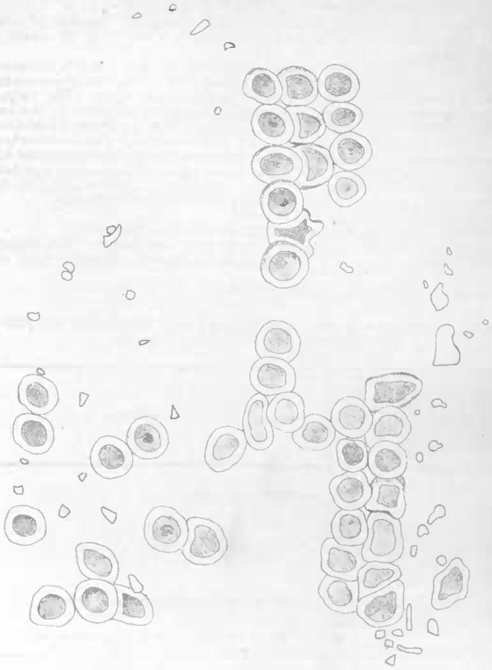
PIG No. 5.—*Inoculated with virus mixed one-half hour before using with four parts of a solution of chloride of zinc 1 to 4000.*

Date.		Hour.	Atmospheric temperature.	Body temperature.	Remarks.
1880.		*A. M.*	° *F.*	° *F.*	
Jan.	5	8.30	43	100½	Inoculated January 3.
	6	9	60	100¼	
	7	10	58	102¾	
	8	8	53	102¼	
	9	9	50	102¼	
	10	8.30	52	102	
	12	8.15	60	102	
	13	9.30	34	99	
	14	8.30	28	97½	
	15	9.15	32	96¾	Scarcely perceptible; discoloration of skin.
	16	9	32	97	
	17	10.30	....	97	
	20	....	....	100½	Redness of skin more marked; slight eruption.

No other symptom of disease observed. Animal preserved.

SWINE PLAGUE AND FOWL CHOLERA.

Microscopic Investigations by D.E. Salmon. D.V.M. Plate I.



Salmon, Del.

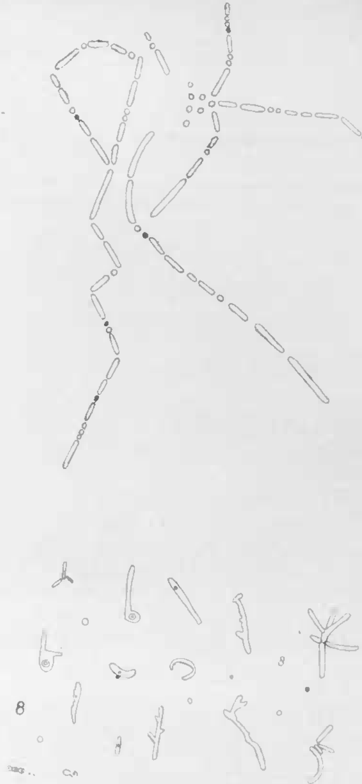
Fig. 1. Swine-Plague: Blood from living animal containing particles of fibrin. x 1200 diam.

A.Hoen & Co Lithocaustic Baltimore

Report Commissioner of Agriculture for 1880.

SWINE PLAGUE AND FOWL CHOLERA.

Microscopic Investigations by D.E. Salmon. D.V.M. Plate II.



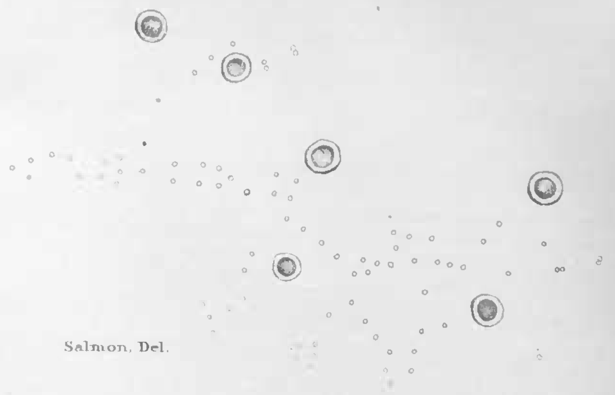
Salmon, Del.

Fig. 2. Swine-Plague: Organisms in preparation of blood from jugular 4 days old. Bacilli forming granules by fission. x 1000 diam.

A. Hoen & Co. Lithocaustic, Baltimore

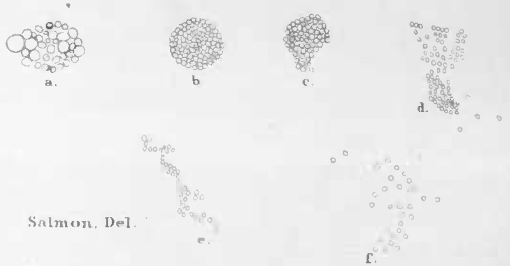
SWINE PLAGUE AND FOWL CHOLERA.

Microscopic Investigations by D.E. Salmon, D.V.M. Plate III.



Salmon, Del.

Fig. 3. Swine - Plague: Relative number of granules and blood corpuscles. From part of a field in the same preparation in which were found the organisms of fig. 2.
×1000 diam.



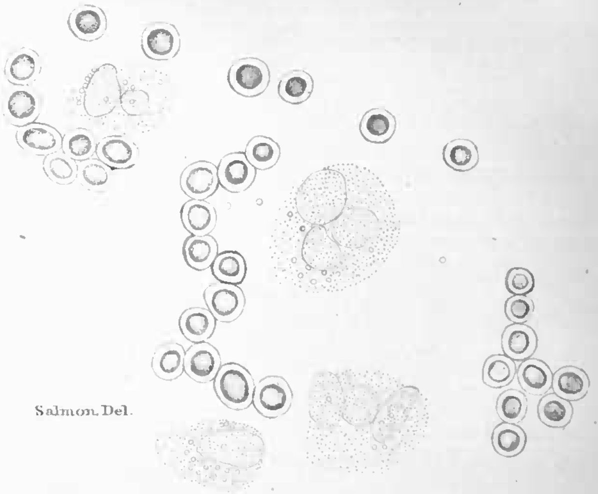
Salmon, Del.

Fig. 4. Swine - Plague: Formation of granules or plastids by wandering cells (leucocytes) in bronchial mucus. a, fat granules; b, c, d, e, f, consecutive stages in the dispersion of the uniform granules (plastids).
× 1000 diam.

A Hoen & Co Lithocaustic Baltimore

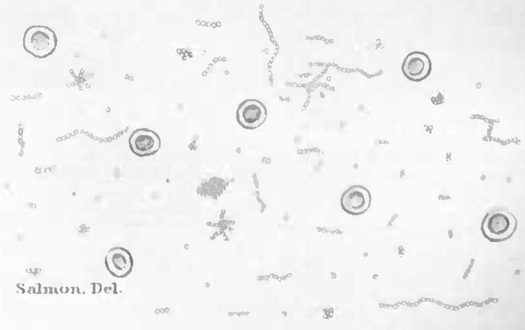
SWINE PLAGUE AND FOWL CHOLERA.

Microscopic Investigations by D.E. Salmon, D.V.M. Plate IV.



Salmon. Del.

Fig. 5. Swine-Plague: Clusters of leucocytes and granules in blood. x 1000 diam.



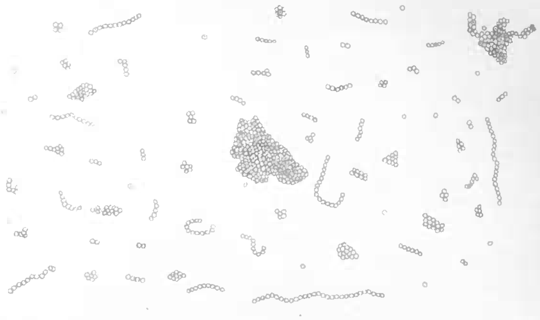
Salmon. Del.

Fig. 6. Swine-Plague: Blood of hog killed near Charlotte, N.C. July 2, 1880. Vacuum tube filled from vein and hermetically sealed ten days before examination. x 1000 diam.

A. Hoen & Co. Lithocaustic. Baltimore

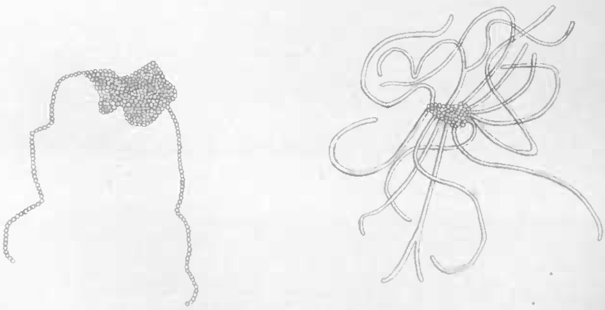
SWINE PLAGUE AND FOWL CHOLERA.

Microscopic Investigations by D.E. Salmon. D.V.M. Plate V.



Salmon, Del.

Fig. 7. Swine-Plague: Virus after seven days cultivation in urine. x 1000 diam.



Salmon, Del.

Fig. 8. Swine-Plague: Exceptional forms developed in cultivations of virus in urine. x 1000 diam.

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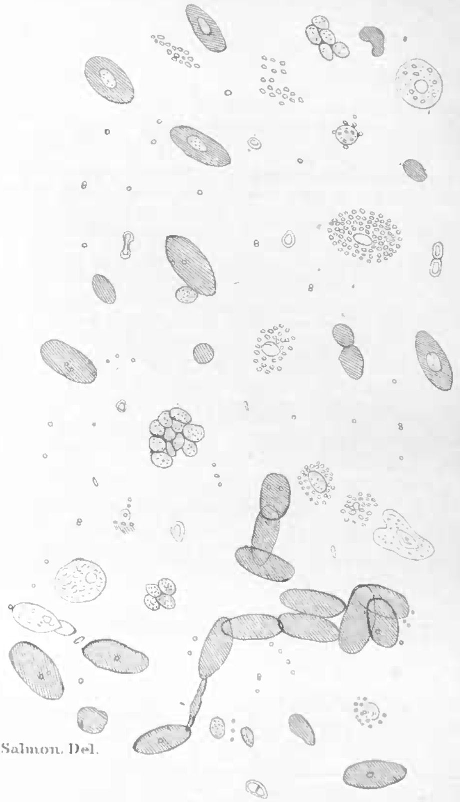
SWINE PLAGUE AND FOWL CHOLERA.

Microscopic Investigations by D. E. Salmon, D.V.M. Plate VI.



Salmon, Del.

Fig. 9. Fowl-Cholera: Blood from Chicken nearly dead; drawn from vein and immediatly examined Aug. 28, 1880.
× 1000 diam.

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SWINE PLAGUE AND FOWL CHOLERA.

Microscopic Investigations by D.E. Salmon. D.V.M. Plate VII.

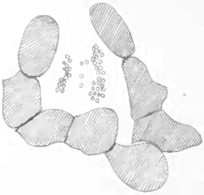

Fig. 10. Fowl-Cholera:
Moving granules. × 1000.

Fig. 11. Fowl-Cholera:
Moving clusters of rod-shaped granules, a, b, & c, successive forms rapidly assumed by the same cluster. × 1000.

Fig. 12. Fowl-Cholera:
Granules about the nuclei of red globules. × 1000.

Fig. 13. Fowl-Cholera:
Osmic acid preparation, showing escape of the nuclei. × 1000.

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Report Commissioner of Agriculture for 1880.

SWINE PLAGUE AND CHICKEN CHOLERA.

Microscopic Investigations by D.E.Salmon.D.V.M. Plate VIII.

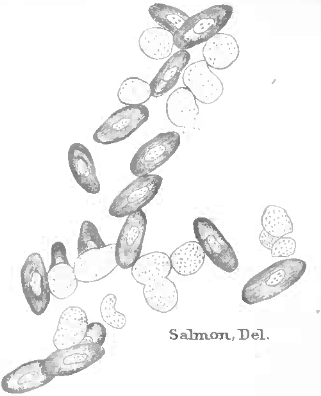

Fig. 14. Fowl-Cholera: Osmic acid preparation from same blood as fig. 9. Shows the large number of leucocytes and absence of free granules and free nuclei. x1000 diam.

Fig. 15. Fowl-Cholera: Appearance of cultivation in moist chamber on slide 20 hours in the incubator. x600 diam.

Fig. 17. Fowl-Cholera: Organisms existing in vast number in the excrement. x1000 diam.

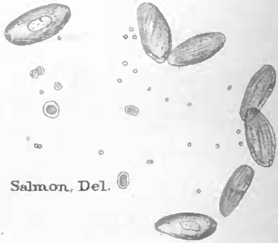

Fig. 18. Fowl-Cholera: Organisms in blood similar to those of excrement. From preparation made Sept. 26. 1880. x 1000 diam.

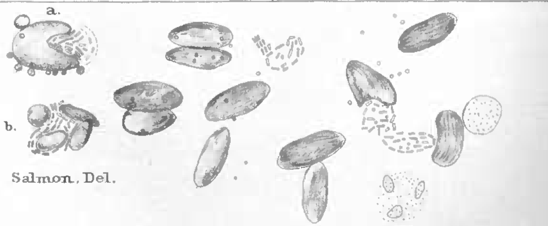

Fig. 16. Fowl-Cholera: Destruction of red corpuscles by leucocytes. a, Soon after contact; b, the same corpuscle ten minutes later. x 1000 diam.

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Report Commissioner of Agriculture for 1880.

SWINE PLAGUE AND CHICKEN CHOLERA.

Microscopic Investigations by D.E. Salmon. D.V.M. Plate IX.

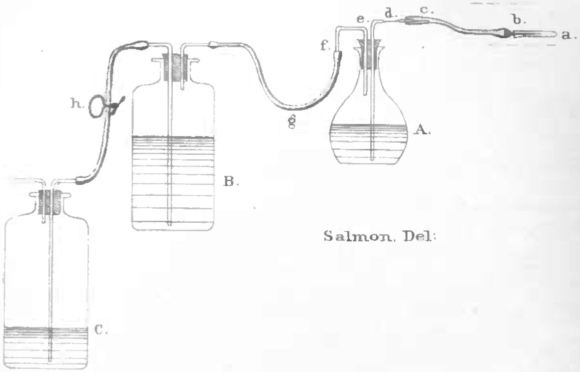

Fig. 19.- Apparatus for introducing blood directly from the veins to a cultivation liquid to avoid contamination with atmospheric germs. A, cultivation flask; b, aspirator needle; a, glass cup packed with cotton; c, point to be broken within the caoutchouc tube; d, part drawn thin to divide and seal with lamp after blood is introduced; e, ventilating tube packed with cotton at f; B and C, aspirator jars.

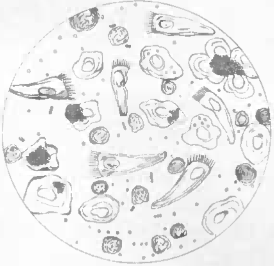

Fig. 20.- Swine-plague: Bronchial mucus (after Méguin). × 600 to 700 diam.

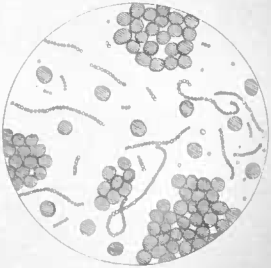

Fig. 21.- Swine-plague: Blood (after Méguin). × 600 to 700 diam.

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SWINE PLAGUE AND CHICKEN CHOLERA.

Microscopic Investigations by D. E. Salmon, D.V.M. Plate X.

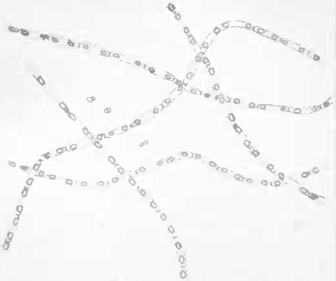

Fig. 22. – Bacillus anthracis: Spore formation after 16 hours cultivation (after Toussaint) × 500.

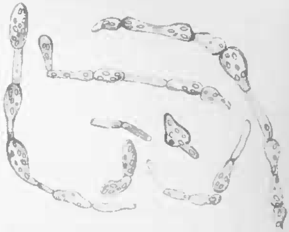

Fig. 23. – Bacillus anthracis. Sporangial forms obtained in serum of dog's blood (after Toussaint) × 500

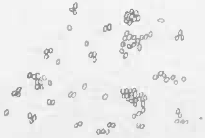

Fig. 24. Bacillus anthracis: Isolated spores (after Toussaint) × 500.

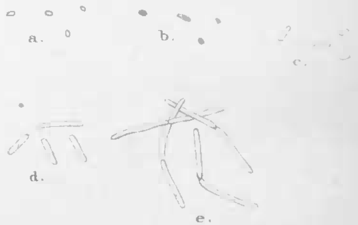

Fig. 25 – Bacillus anthracis: Development of spores in cultivation Liquids — (a), when planted; (b), in half hour; (c), in one hour; (d), in two hours; (e), in three hours (after Toussaint) × 500

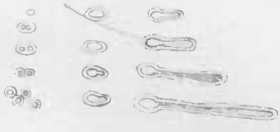

Fig. 26. – Bacillus anthracis. Spore dividing into sporules and one of these developing into a rod (after Ewart.) ×

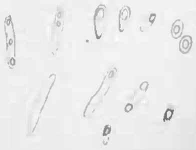

Fig. 27. Bacillus anthracis: Germination of spores (after Cohn) × 1650

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PIG No. 6.—*Inoculated with virus mixed one-half hour before using with four parts of a solution of chloride of zinc 1 to 3000.*

Date.	Hour.	Atmospheric temperature.	Body temperature.	Remarks.
1880.	*A. M.*	° *F.*	° *F.*	
Jan. 5	8.30	43	102½	Inoculated January 3.
6	9	60	103¾	
7	10	58	103½	
8	8	53	103¼	
9	9	50	104	
10	8.30	52	103½	
12	8.15	60	103	
13	9.30	34	103	
14	8.30	28	102	
15	9.15	32	100½	Slight redness of skin.
16	9	32	100¾	Dull purple patches on skin.
17	10.30	....	100½	
20	....	....	99½	

No additional development of disease. Animal preserved.

PIG No. 7.—*Inoculated with virus treated with four parts of a solution of chloride of zinc 1 to 5000, one-half hour before using.*

Date.	Hour.	Atmospheric temperature.	Body temperature.	Remarks.
1880.	*A. M.*	° *F.*	° *F.*	
Jan. 5	8.30	43	101½	Inoculated January 3
6	9	60	101¾	
7	10	58	103¾	
8	8	53	103¾	
9	9	50	100	
10	8.30	52	100¼	
12	8.15	60	99	
13	9.30	34	98¾	
14	8.30	28	99¼	
15	9.15	32	98½	Very thirsty; covered with eruption.
16	9	32	97½	Increase of eruption.
17	10.30	....	100	Dull.
20	....	....	101¾	Very red on inner side of thighs and on abdomen; ears lopped; dullness marked.

Killed by bleeding, January 23.

A peculiarity of this, as well as of the other animals of this series, was that none had the appearance, to the casual observer, of being sick. All had good appetites; indeed, would squeal lustily at feeding time till they received their share. The emaciated appearance, the arched back, the tucked-up abdomen, the staggering gait, the tendency to hide in the litter and keep quiet, the continued elevated temperature which are generally observed, were nearly or entirely absent. This animal had a very profuse eruption, a few petechial spots, the ears were slightly lopped, and from a very fierce, aggressive animal, she became more gentle and tractable. These were the only external signs of the disease.

Post-mortem examination.—*Abdominal organs:* On incising the walls of the abdomen a considerable number of spots of extravasated blood were noticed in the areolar tissue; there were two or three ounces of clear effusion in the abdominal cavity; patches of congestion in both large and small intestines; enlarged and hyperæmic lymphatic glands; slight congestion of kidneys and liver, but less than usual of the inflammatory; new formation uniting the intestines. The *Stephanurus dentatus* abounded about the kidneys and had caused the formation of a false membrane on their surface; there were, also, many of the *Echinorynchus gigas* in the small intestines.

Thoracic organs: On opening the thorax there could no longer be doubt of the presence of the disease. Nearly the entire tissue of both lungs was of a deep red color

and hepatized. The right lung was adherent to the thoracic wall, about midway between spine and sternum, by a delicate, transparent, though very resisting false membrane. Greatly distended blood-vessels were to be traced on the surface of the lung.

On following the bronchi nearly to their termination, a few very small, evidently young, worms (*Strongylus elongatus*) were found.

INVESTIGATIONS OF BACTERIA, PARTICULARLY OF THE MICROCOCCUS FOUND IN SWINE PLAGUE VIRUS, AND THE EFFECT OF DISINFECTANTS UPON THEM.

EXPERIMENT No. 1.—*Forms arising spontaneously in urine.*—In each of six test tubes was placed 20 cubic centimeters of fresh urine; the tubes were then closed by tying a piece of sheet caoutchouc tightly over the top. They were then heated to 87.8° C. (190° F.) for fifteen minutes—the highest point that could be reached without danger of explosion. The covers of Nos. 1, 2, and 3 were then removed for one minute and again replaced as before: all were now placed in an incubator at 90° F. for five days. A seventh tube, containing the same liquid, was allowed to stand loosely corked in the laboratory for comparison.

Results of examination, March 24, 1880.

All examinations made with a Tolles one-fifteenth objective.

Tube No. 1: Liquid clear; neither membrane nor deposit. Contained moving bacilli answering the description of *Bacillus subtilas*; elliptical granules, which I shall hereafter speak of as *bacillus* spores—having traced their origin so often as to dispel all doubts; and a considerable number of small aggregations of spherical granules, but no chains of these—the individual granules were $\frac{1}{30000}$th of an inch, or somewhat less, in diameter.

Tube No. 2: Membrane on surface; liquid clear; no deposit. Contains vast numbers of the *bacillus* spores and a few of the rods.

Tube No. 3: Liquid clear; no membrane; slight flocculent deposit. Contains bacilli and spores as in Nos. 1 and 2; also, rods $\frac{1}{3000}$th to $\frac{1}{6000}$th of an inch in length, and $\frac{1}{35000}$th of an inch in diameter, with an elliptical granule at one end, the long diameter of which was apparently at right angles to the rod (helobacteria).

Tube No. 4: No membrane on surface; liquid clear; slight flocculent deposit. Contains *bacilli* and spores; also, many motionless spherical granules, just visible, having the appearance of *débris* rather than of living bacteria.

Tube No. 5: Grayish-brown membrane on surface; liquid clear; no deposit. *Bacilli* of two distinct sizes, one being of the diameter of *B. subtilis* ($\frac{1}{25000}$th inch), the other much finer ($\frac{1}{40000}$th inch), both existing as short moving rods and as matted masses of filaments, some of which were forming spores; many free spores of the former; a single aggregation of spherical granules, having the characters of the swine plague micrococci.

Tube No. 6: Grayish-brown membrane on surface; liquid clear; no deposit. Many *bacilli* as rods and filaments, some containing spores and immense number of free spores.

Tube No. 7: Surface covered with a membrane; liquid turbid; slight deposit. Myriads of flexible rods in movement having the characters of Pasteur's *butyric vibrio.* A few isolated spherical granules and one small aggregation.

From this experiment we may conclude that there exists in the air the spores of *bacilli* of different varieties, the diameter of some not being over $\frac{1}{40000}$th of an inch, and that some of these multiply by forming elliptical spores; also, that helobacteria and spherical micrococci may be found under similar conditions. A temperature of 190° F. for fifteen minutes is plainly insufficient to destroy the germs of these organisms.

EXPERIMENT No. 2.—*Effects of inoculating urine in tubes with micrococci of swine plague.*—Six test tubes were prepared as in experiment No. 1, and after being heated to the same degree for the same time, the covers were removed and four drops of an infusion of beef, in which the swine plague micrococci had been cultivated, were added to the contents of each tube. The infusion was swarming with clusters of this organism.

Results of examination after ten days.

Tube No. 8: No membrane on surface; liquid turbid; slight deposit. Contains nothing but spherical granules existing in vast numbers, singly, in couples, and clusters.

Tube No. 9: No membrane; liquid turbid; slight deposit. Contains immense numbers of micrococci as in the preceding and a few bacillus rods.

Tube No. 10: No membrane; liquid turbid; slight deposit. Swarms with the micrococci, single, in couples, chains, and clusters.

Tube No. 11: Liquid covered with a membrane; turbid with a flocculent deposit. A few micrococci and *bacilli* have gained possession of the liquid, and it swarms with the rods and elliptical spores.

Tube No 12: Membrane; liquid clear; no deposit. Contain so many bacillus rods that the few micrococci could only be found with difficulty.

Tube No. 13: Membrane; liquid clear; no deposit. Swarms with *bacilli* and spores.

It was concluded from this experiment that by adding the micrococci in considerable quantity to the cultivation liquid, and by closing the tube so that but a few spores could gain entrance from the air, a nearly pure growth of these could be obtained in a sufficient number of cases to admit of the following experiments being made.

It is also to be noticed that the liquids presented a different appearance to the naked eye, according as they were the growth of the micrococci or the bacilli. The former organism commenced its multiplication at the bottom of the tube, and the turbidity caused by its increase gradually extended towards the surface, while a whitish deposit, composed of the clusters, accumulated at the bottom. It is only after longer periods that I have noticed a delicate membrane form on the surface of what I believe to be pure cultivations of this organism. The *bacilli*, on the contrary, have such a pressing need for oxygen that they multiply mostly on the surface, very soon forming a membrane, while the liquid remains clear and in some cases a flocculent deposit is formed. Of course, I only apply these remarks to the *bacilli* arising spontaneously in these cultivations, since other varieties of this genus are sometimes met with having different characteristics.

EXPERIMENT NO. 3.—*Effect of carbolic acid on development.*—Six test tubes were prepared March 19, 1880, as in the preceding experiments, and sufficient carbolic acid solution added to make their entire contents of the strength indicated below. Two tubes contained 2 per cent. of the acid, because a 90 per cent. solution was added to the first, and as it would not diffuse itself, a second tube was prepared with a more dilute solution; the former mixed perfectly after a few hours, however. To each of these tubes was added four drops of infusions containing the cultivated micrococci; they were then covered as before, and placed in an incubator heated to 90°–100° F.

Results of examination after six days.

Tube No. 14: 1 part carbolic acid to 400 of liquid. No membrane; considerable deposit and turbidity. Swarms with the micrococci throughout, though they are most numerous at the bottom.

Tube No. 15: 1 to 300. No membrane; turbid, with deposit. It is perfectly crowded with micrococci.

Tube No. 16: 1 to 200. No membrane; turbid, with deposit. Micrococci as above; a few *bacilli*.

Tube No. 17: 1 to 100. Membrane and turbidity; no deposit. Near the surface there are mostly *bacilli* and spores with a few micrococci; at the bottom the conditions are reversed and the micrococci are found in great numbers.

Tube No. 18: 1 to 50. Slight cloudiness of liquid; no membrane or deposit. Swarms with the micrococci in chains and various shaped aggregations—there are also some vibrios.

Tube No. 19: 1 to 50. Perfectly transparent and clear as when first placed in the incubator. Contains no sign of life. This was the tube in which the carbolic acid did not mix as soon as added; and it is probable that the micrococci when added descended to the bottom, and here came in contact with a solution of the acid much more concentrated than is indicated by the proportion used, and were thus destroyed.

A 1 per cent. solution of carbolic acid is not sufficient, therefore, either to destroy this organism or prevent its multiplication.

EXPERIMENT NO. 4.—*Effect of carbolic acid on vitality.*—In experiment No. 3 we have seen that in one case the micrococci were able to multiply themselves in a solution containing even 2 per cent. of carbolic acid; in another case containing the same proportion of the disinfectant they did not multiply; were they simply hindered from developing while retaining their vitality, or were they destroyed? To answer this question, six watch-glasses were well flamed and in each was placed a few drops of a solution containing the micrococci, then sufficient of a strong solution of carbolic acid was added to make the whole of the strength indicated below. After standing one hour under a bell-glass the contents of each watch-glass were used for inoculating a tube prepared as in the other experiments, and this was kept at 90° F. for ten days.

Results of examination, April 1, 1880.

Tube No. 20: 1 to 400. Liquid turbid; very thin membrane and some deposit. Contains some *bacilli* and spores at the surface, but the micrococci abound and are particularly numerous at the bottom.

Tube No. 21: 1 to 300. Liquid slightly turbid; no membrane; some deposit. Many micrococci and some *bacilli* and spores.

Tube No. 22: 1 to 200. Liquid slightly turbid; no membrane; scanty deposit. Many clusters of micrococci mostly at the bottom.

Tube No. 23: 1 to 100. Liquid slightly turbid; no membrane; scanty deposit. Swarms with micrococci; there are also a few bacillus filaments.

Tube No. 24: 1 to 50. Liquid turbid; covered with a membrane; no deposit. At the surface were found a few micrococci, single and in chains, but deeper in the liquid; they could scarcely be discovered. My impression was that there were no more in the tube than were placed there by inoculation, and that consequently those found were incapable of multiplication, and, therefore, dead. There were many *bacilli* and their spores and some helobacteria (sprouting *bacilli?*).

Tube No. 25: 1 to 25. Slightly turbid; no membrane; scanty transparent deposit. A very few micrococci were found, but probably they were the ones added.

In this experiment there is a confirmation of the results of the preceding one, and it is proved that the micrococci are not affected by solutions containing 1 per cent. or less of carbolic acid. Two per cent. of the acid, however, seemed to destroy this organism, as in one of the tubes in the preceding experiment. If these micrococci, then, are the pathogenic agent, we cannot expect a weaker solution than 2 per cent. of carbolic acid to be of any value as a disinfectant.

EXPERIMENT No. 5.—*Effects of borate of soda on development.*—In each of five test tubes was placed 20^{cc} of fresh urine, then five drops of a solution swarming with the micrococci, and, finally, sufficient of a 10 per cent. solution of borax to make the whole contain the proportion of the salt indicated below. The tubes were then covered with sheet caoutchouc and placed in an incubator at 95° for four days.

Results of examination, March 31, 1880.

Tube No. 26: 1 to 1,000. Liquid turbid; no membrane; slight deposit. Contains many micrococci.

Tube No. 27: 1 to 500. Liquid turbid; delicate membrane; slight deposit. Many micrococci and *bacilli.*

Tube No. 28: 1 to 300. Liquid cloudy with floating flocculi; no membrane; no deposit. Swarms with micrococci and *bacilli.*

Tube No. 29: 1 to 100. Liquid turbid; covered with a thin membrane; no deposit. Contains many clusters of micrococci, also *bacilli* and their spores—some of the rods show spore formation.

Tube No. 30: 1 to 50. Liquid clear with a slight transparent deposit. Only two small clusters of micrococci could be found, and no other bacteria forms were present. There had, consequently, been no multiplication of the organism.

A 2 per cent. solution of borax, therefore, prevents the growth of this micrococcus, having the same effect as a carbolic acid solution of the same strength. We have here an illustration of what may be expected of such studies as indications of treatment; these two substances having the same effect, borax would of course be preferable for internal use, since it can be given in twenty to thirty times the quantity.

EXPERIMENT No. 6.—*Effect of benzoic acid on development.*—The experiment was conducted exactly as No. 5, with the exception that benzoic acid solution was used, containing 1½ parts of borax to each part of acid to effect the solution of the latter, and the tubes remained five days in the incubator.

Results of examination, April 3, 1880.

Tube No. 31: 1 to 1,000. No membrane; liquid turbid; gelatinous deposit. Contains numbers of micrococci and a very few *bacilli.*

Tube No. 32: 1 to 500. Same appearance as No. 31. Contains clusters of micrococci and a very few bacillus spores.

Tube No. 33: 1 to 300. Same appearance as No. 31. Large numbers of micrococci, with a few vibrios and bacillus spores.

Tube No. 34: 1 to 100. Liquid perfectly clear, with the exception of a very transparent cloud near the bottom having the appearance of crystals. Under the microscope there could only be discovered a very few bacillus spores and a single rod. No micrococci.

Tube No. 35: 1 to 50. Appearance same as No. 34. One or two bacillus spores were the only organisms discovered.

A 1 per cent. solution of benzoic acid with borax, therefore, prevents the multiplication of these micrococci, and is, consequently, much more efficacious than carbolic acid.

EXPERIMENT No. 7—*Effect of sulphate of quinine on development.*—Experiment conducted same as No. 5.

Results of examination.

Tube No. 36: 1 to 1,000. Liquid turbid, with a gelatinous cloud at the bottom. Contains micrococci, *bacilli* as rods and filaments, some of which are forming spores and vibrios.

Tube No. 37: 1 to 500. Appearance and contents same as No. 36.

Tube No. 38: 1 to 300. Liquid clear; a cloud of transparent substance resembling crystals floating near the bottom. A very few micrococci were found, but probably not more than were added.

Tube No. 39: 1 to 100. Liquid slightly turbid; scanty flocculent deposit. A very few micrococci and *bacilli* were found.

Tube No. 40: 1 to 50. Liquid perfectly clear. A very few micrococci.

From this experiment I have concluded that the one-third-of-a-per-cent. solution prevented the multiplication of the organism.

EXPERIMENT No. 8.—*Effect of quassia.*—Solid extract of quassia, dissolved and added to the tubes prepared as before, in the proportion named.

Tubes Nos. 41 to 45: 1 to 500; 1 to 300; 1 to 100; 1 to 50; 1 to 25. Liquid turbid; membrane and abundant deposit. All swarmed with the micrococci and considerable numbers of *bacilli* and bacillus spores.

EXPERIMENT No. 9.—*Effect of salicylic acid.*—Tubes prepared as before, to which were added salicylic acid containing 1½ parts of borax to each part of acid to cause solution.

Examination, April 3, 1880.

Tube No. 46: 1 to 1,000. Liquid turbid, with gelatinous-looking cloud near the bottom. Contains micrococci single and in couples, clusters and chains; also *bacilli.*

Tube No. 47: 1 to 500. Decidedly turbid. Contains bacilli and spores in considerable number, and only a very few micrococci.

Tube No. 48: 1 to 300. Appearance and contents same as in No. 47, except there are no micrococci.

Tube No. 49: 1 to 100. Liquid nearly clear. Contains many bacillus spores and rods, but no micrococci.

Tube No. 50: 1 to 50. Liquid perfectly clear. No organisms.

EXPERIMENT No. 10.—*Effect of chloride of zinc.*—Tubes prepared as before.

Tube No. 51: 1 to 3,000. Liquid turbid; abundant white deposit. Swarms with micrococci, with a few *bacilli* and vibrios.

Tube No. 52: 1 to 1,000. Liquid clear; white deposit. A few *bacilli* and spores were found, as also some dumb-bell bacteria, but none of the clusters or chains of micrococci.

Tube No. 53: 1 to 500. Liquid clear; no deposit. A very few bacillus spores were observed actively rotating, but no other sign of life.

Tubes Nos. 54, 55, *and* 56: 1 to 300; 1 to 100; 1 to 50. Liquid clear, with a brownish deposit and a little brownish matter floating on surface; under the microscope this seems to be of a crystalline nature. There had been no multiplication of micrococci.

EXPERIMENT No. 11.—*Effect of iodine.*—A 10 per cent. solution of iodine was made in distilled water, by first dissolving 20 per cent of iodide of potassium, and sufficient of this was added to the tubes prepared as before to make them contain the required quantity of iodine. These remained in the incubator four days at 95° F.

Results of examination.

Tube No. 57: 1 to 6,000. Liquid turbid. Contains micrococci in large numbers, mostly in chains; also, *bacilli* and spores.

Tube No. 58: 1 to 3,000. Liquid turbid. Micrococci in clusters and chains, but in small number; many *bacilli* and spores.

Tube No. 59: 1 to 1,000. Liquid clear, with a transparent cloud near the bottom of tube. Contains many *bacilli*, some of which seem to be breaking up into dumb-bell forms, elliptical spores, and a few micrococci.

Tube No. 60: 1 to 500. Liquid contains a transparent flocculent deposit. There are many *bacilli* and a few micrococci.

Tube No. 61: 1 to 300. Liquid transparent. No sign of living organisms.

Tube No. 62: 1 to 100. Liquid transparent and free from organisms.

EXPERIMENT No. 12.—*Effect of heat.*—In this experiment the contents of the tubes had the addition of two to three drops of a cultivation swarming with micrococci; the tubes were then closed and placed in a water bath at the temperature and for the time noted in the description of each tube. The tubes were then placed in an incubator, and kept at 95° F. for two days before examination.

Results of examination, April 10, 1880.

Tube No. 63: 130° F. for 15 minutes. Liquid turbid. Swarms with micrococci, and also contains a few *bacilli.*

Tube No. 64: 140° F. for 15 minutes. Liquid turbid; a gelatinous cloud near the bottom. Contains vast numbers of micrococci, with *bacilli,* elliptical spores, and vibrios.

Tube No. 65: 150° F. for 15 minutes. Liquid turbid; whitish deposit. No micrococci; contains only rod forms of bacteria.

Tube No. 66: 160° F. for 15 minutes. Appearance and contents of liquid similar to that in No. 65.

Tube No. 67: 208° F. for 5 minutes. Appearance of liquid and organisms found do not differ materially from No. 65.

OBSERVATION ON THE EFFECT OF VARIATIONS OF THE ATMOSPHERIC TEMPERATURE ON THE BODY TEMPERATURE IN HEALTH.

The temperature of animals is regarded with reason as a most important symptom in various contagious diseases; but it soon becomes evident to the observer that the temperature during health is subject to very considerable fluctuations. These are evidently due to what we may term internal and external causes. The most important of the former is probably the amount of liquid passed through the organism, and of the latter the variations of temperature of the atmospheric air and the amount of humidity which it contains. The following observations made on a healthy calf will, it is hoped, throw some light on the effect of atmospheric temperature.

Date.	Hour.	Atmospheric temperature.	Body temperature.
1879.		°F.	°F.
Dec. 1	7.45 a. m	34	99.75
	5.10 p. m	40	103.
2	7 a. m	20	98.75
	4.50 p. m	54	103.25
3	7 a. m	42	101.5
	5 p. m	58	103.
4	7.10 a. m	52	101.5
	5 p. m	56	102.75
5	7.15 a. m	54	101.75
	5 p. m	58	103.5
6	7.15 a. m	55	102.5
	5 p. m	54	102.75
7	7.50 a. m	36	101.25
	5 p. m	58	101.
8	7.25 a. m	33	100.5
	5 p. m	54	102.
9	7 a. m	42	101.75
	5 p. m	58	102.75
10	7.45 a. m	54	102.25
	5 p. m	62	103.5
11	7.45 a. m	58	102.75
	5. a. m	38	103.25
12	7 a. m	28	102.
	5.05 p. m	34	102.
13	7.15 a. m	28	101.
	5 p. m	40	101.25
14	8.20 a. m	40	102.25
	4.45 p. m	50	103.25
15	7.45 a. m	44	102.25
	5 p. m	40	102.25
16	7.45 a. m	32	100.25
	5 p. m	45	103.75
17	7.45 a. m	46	101.5

This gives an average morning body temperature of 101°.4, and an average evening temperature of 102°.7; being an average difference of 1°.3 between about seven in the morning and about five in the evening. The lowest temperature was 98°.75, and the highest 103°.75, a difference of five degrees, the animal being the whole time in good health. The lowest temperature of the body corresponded with the lowest of the atmosphere; and, in general, a considerable change in atmospheric temperature was followed by a change of body temperature in the same sense, though this did not always take place, and when it did there was no definite relation between the extent of the two changes. The eight mornings on which the atmospheric temperature was 40° or under, the average body temperature was 100°.72 and that of the air 31°.4; the nine mornings on which the atmospheric temperature was above 40°, the average body temperature was 101°.97, and that of the air 49°.7; thus an average increase of 18°.3 in the atmosphere caused an average increase of 1°.25 in body temperature. Again, the five evenings on which the atmospheric temperature was 40° or under, the average body temperature was 102°.35, and the average atmospheric temperature 38°.4; the eleven evenings on which the temperature of the air was above 40°, the average body temperature was 102°.86, and the average of the air 55°.2; an average increase of 16°.8 in evening temperature of the air, causing an average increase of 0°.51 in body temperature.

INVESTIGATION OF SWINE PLAGUE.

THIRD REPORT OF DR. JAMES LAW.

Hon. WILLIAM G. LE DUC,
Commissioner of Agriculture:

SIR: I have the honor to submit a report of experiments on swine plague, undertaken with the view of determining how far the virus can be mitigated by artificial means, so that the disease may be made to assume a mild or harmless form, and how far such mitigated type of the malady will prove protection against the effect of a second exposure to infection. That I have succeeded in securing such protection it is perhaps as yet too much to assert, yet observation seems to show that inoculation with the virus which has been cultivated in certain organic solutions is attended by little danger to the animal, and yet produces a condition of the system which is protection against the dangers of a renewed exposure to infection, and also against the perils usually attending inoculation with a moderate amount of the ordinary or native virus. It has shown none the less clearly that the poison as cultivated in certain other organic mixtures becomes very deadly; that the virus that has been shut up for some time, with a limited amount of air, is no less so, and that the introduction into the system of a maximum dose of the more potent forms of the poison will put all protective measures to naught.

The work has necessarily been slow because of the delay needful to allow of the action of the poison on the animal system and the full recovery from the same, and afterward by reason of the time necessary to submit the convalescent animals to the tests required to ascertain the existence and measure of the acquired insusceptibility, and also because the number of subjects was limited, so that each might be kept apart from dangerous infection during the early stages of the experiment. Further delay necessarily occurred when an experiment turned out adversely to our hopes, and necessitated a change of base and a new and different line of investigation.

In submitting the results of this work I have furnished the record of each experiment separately, with comments, and wound up by a summary of deductions, which will serve as a basis for experiments on a larger scale.

PIG NO. 1.

Small Berkshire pig, obtained from Mr. Frear, is out of a small herd, of which three have died of swine plague, introduced by a purchase from New Jersey. This and another, the only survivors of the herd, I

secured for experiment. It had not been thought seriously ill, but looked emaciated and scoured on arrival.

Date.	Time.	Body temperature,—rectum.	Remarks.
1880.		°F.	
June 9	....	103	Fed green vegetables, corn meal, and bread.
10	9 a. m.	102	Scours; looks ill.
	6 p. m.	103	Do.
11	9 a. m.	104	Do.
12	m	102	Scours; looks ill; fed shorts.
13	9 a. m.	101.5	Do.
14	....do	101.75	Hearty; hungry; bowels settled.
15	....do	101.75	Do.
16	....do	101.75	Do.
17	....do	101.5	
18	....do	101.5	
19	....do	101.5	
20	....do	101.5	
21	....do	102	
22	....do	101.75	
23	6.30 p. m.	102.5	Inoculated with lung liquids of sick pig. Killed to-day at Horseheads. See microscopic drawings, figs. 1, 2, 3.
24	9 a. m.	101.5	Swelling where inoculated. Weak grunt.
25	....do	101.5	
26	....do	101.75	
27	....do	102.5	
28	....do	102	
29	....do	101.5	
	6 p. m.	102	
30	9 a. m.	101.5	
	6 p. m.	102	
July 1	9 a. m.	101.75	Inoculation swelling persists.
2	....do	101.5	Purging, but good appetite.
	6 p. m.	102	Do.
3	9 a. m.	101.5	Do.
	6 p. m.	101.5	Do.
4	9 a. m.	101	Do.
	6 p. m.	101.5	Do.
5	9 a. m.	102	Do.
	6 p. m.	103	Purging badly digested matter; greenish water, with floating solids.
6	9 a. m.	100	
	6 p. m.	102	Purging; scurfy; skin exudation.
7	9 a. m.	103.75	Do.
	6 p. m.	103.5	Do.
8	9 a. m.	100	Purging; scurfy; very feverish grunt.
9	....do	99	Purging; looks much worse.
	6 p. m.	105	Do.
10	9 a. m.	100	Inoculated with peritoneal exudate of a pig killed 8 days ago in North Carolina, by Dr. Salmon. Kept in vacuum tube till 36 hours ago. Smells of hog, but not putrid.
	6 p. m.	102	
11	9 a. m.	102	
	6 p. m.	100	Very dull and prostrate.
12	9 a. m.	101.5	
13	....do	101	
14	....do	100	Very sick; likes to be rolled over. Stands drawn together, with back arched and nose extended.
15	6 p. m.	99	Very prostrate, weak grunt, purges.
16	....do	98	Very weak; has to be raised.
17	9 a. m.	100.5	Unable to rise. Seems just breathing.
	12 noon	....	Found dead.

POST-MORTEM EXAMINATION SAME AFTERNOON.

Rigor mortis slight. Skin thin and bloodless, covered with a thick black exudation dried at most points and scaling off. The left ear, where it had been punctured two weeks ago for a drop of blood, presents a small slough about a line in diameter, and when pressed exudes a drop of white pus-like matter.

The seat of the first inoculation in the flank exudes a few drops of a red grumous fluid, and contains a yellowish white slough inclosed in a sac with thick bluish white walls.

The seat of the second inoculation, situated in front of the last and close to the costal cartilages, presents an abscess with ½ drachm of a whitish purulent fluid, and inclosed by thickened whitish fibroid walls. Immediately below this the muscular walls of the abdomen by the span of an inch long by half an inch broad have undergone extensive thickening and fibroid degeneration.

Superficial inguinal glands are deeply pigmented, presenting a dark blue tinge. Enlargement very slight.

The *sublumbar, gastric,* and *mesenteric glands* are similarly pigmented The *prescapular glands* are deeply pigmented The *prethoracic glands* congested, of a deep red color. The *pharyngeal submaxillary glands* pigmented. *Mouth* and *pharynx* normal.

Stomach: Great curvature has the mucous membrane red and congested.

Small intestine shows partial congestion.

Cæcum shows a number of sloughing ulcers. The sloughs are of a yellowish white color, and do not project much above the adjacent mucous membrane.

Colon has fewer and smaller sloughs of the same general character.

The cæcum and anterior part of the colon contain many whipworms (*Tricocephalus dispar*).

Lungs normal or nearly so. The right is of a dark red color, from a congestion which is manifestly hypostatic and post-mortem.

Right heart contains a small clot. Left heart empty.

Spleen normal.

Kidneys and *Wolffian bodies* congested and red. There a is great deficiency of fat throughout the body.

Remarks on Pig No. 1.

This pig came into my possession as a sick animal, and was besides small and badly nourished. Fourteen days later, when it had been manifestly improving for a week, it was inoculated by injecting under the skin a drachm of the fresh pulmonary exudate of a sick (swine plague) pig killed the same day at Horseheads. It seemed important to test the insusceptibility of the animal at this early stage of recovery, as the companion pig No. 2 being now in a more advanced state of convalescence (by about ten days), furnished the opportunity for a comparison. The immunity or insusceptibility acquired by swine that had passed through the disease and fully recovered we took for granted on the testimony of men of experience, so that the question with us, and which those pigs seemed to offer a chance of determining, was at how early a date after the attack could this immunity be counted on.

In inoculating as stated, with such a large amount of the virulent liquid, we made the test one of the most severe possible, and one much more exacting than if we had simply placed the experimental pig in the same pen with a sick one, or inserted a single drop of the virulent liquid under the skin. In his experiments with anthrax, Chauveau has shown that the probability of a fatal result is far greater if the virus is introduced, as in this case, in a large quantity at a time, than after even a succession of inoculations of a limited amount.

By a parity of reasoning, it is probable that the swine plague, which is presumed to be caused, like anthrax, by bacteridian infection, will show itself to be subject to the same laws of development and prophylaxis, and therefore the sudden saturation of the blood with a drachm of virulent fluid was much more likely to bear down all protective opposition than if the poison had gained access to the system through the natural channels as infinitesimal particles floating in the air, or as virulent liquids that might come in contact with any chance sore on the surface.

The case No. 1, which terminated unfavorably, clearly established two points: 1st. That the protection furnished to an animal by a first attack of the disease, even when that is contracted in the natural manner, is not yet secured so long as the system is still suffering from the active effects of such first attack. 2d. That a very large dose of the virus of

swine plague manifestly acts on the system with greater potency than a small one.

Both of these conclusions were still further strengthened by the results of a second inoculation practiced seventeen days after the first, and while the system was still profoundly affected by the latter. The patient sank rapidly after the second inoculation, and died on the seventh day, presenting at the necropsy the characteristic lesions of the plague.

LARGE BERKSHIRE PIG, No. 2.

Sent me from Mr. Frear's, June 9, 1880, from a herd that was infected with hog cholera by a purchase of some hogs from New Jersey. This pig has been sick but is recovering. This and No. 1 are the sole survivors of the herd. On arrival it was still plump and hearty, the main signs of disorder being an extra exudation from the skin and a very slight irregularity of the bowels.

Date.	Time.	Body temperature.	Remarks.
1880.		° F.	
June 9		104	Bowels slightly irritable.
10	9 a. m.	103.5	
10	6 p. m.	103.2	
11	9 a. m.	104	
12	M.	102	Bowels settled. Fed shorts.
13	9 a. m.	102	
14	...do.	101.5	
15	...do.	101.5	
16	...do.	101.5	
17	...do.	101.5	
18	...do.	101.5	
19	...do.	101.5	
20	...do.	101.5	
21	...do.	101.5	
22	...do.	101.5	
23	6.30 p. m.	103	Inoculated with diseased lung of pig killed at 1 p. m. the same day at Horseheads; ½ drachm of the liquid injected under the skin.
24	9 a. m.	101.5	Slight swelling in seat of inoculation.
25	...do.	101.5	
26	...do.	101.5	
27	...do.	103	
28	...do.	102	
29	...do.	102.5	
29	6 p. m.	104	Swelling in seat of inoculation hard and 1½ inches in diameter.
30	9 a. m.	103	
30	6 p. m.	104	
July 1	9 a. m.	102	Inoculation swelling red; its bristles shed.
2	...do.	101.5	Abrasion on swelling, with oozing of serum.
2	6 p. m.	103	Excellent appetite.
3	9 a. m.	101.5	
3	6 p. m.	102	
4	9 a. m.	101	
4	6 p. m.	102	
5	9 a. m.	103	Wound dry. Swelling less but very itchy. Skin harsh, scaly.
5	6 p. m.	103	
6	9 a. m.	101	Coughs.
6	6 p. m.	103.75	Coughs. Unctuous, blackish skin exudation.
7	9 a. m.	103	
7	6 p. m.	103	
8	9 a. m.	101	
9	...do.	103	
9	6 p. m.	104.5	
10	9 a. m.	103	Inoculated with peritoneal exudate from sick pig in North Carolina; virus kept 8 days in vacuum tube and smells strongly of pig, but not fœtid; ½ drachm injected hypodermically.
10	6 p. m.	104.9	
11	9 a. m.	104.9	Swelling where inoculated 7 hours after the injection.
11	6 p. m.	103	
12	9 a. m.	104.75	
13	...do.	104	
14	...do.	103	

LARGE BERKSHIRE PIG, NO. 2—Continued.

Date.	Time.	Body temperature.	Remarks.
1880.		° *F.*	
July 15	6 p. m	103	
16	....do	104	Looks hearty. Only slight swelling where last inoculated. Skin scurvy, itchy.
17	9 a. m	101.5	
17	6 p. m	101	
18	9 a. m	104.4	
18	6 p. m	103.75	
19	9 a. m	100.5	
19	6 p. m	104	
21	9 a. m	102.5	
22	....do	104	
22	6 p. m	102	
23	9 a. m	101	
23	6 p. m	103.75	
24	9 a. m	102.25	
24	6 p. m	105	After supper.
25	9 a. m	103	
25	6 p. m	105.25	Do.
26	9 a. m	103	
26	6 p. m	104	
27	9 a. m	102.25	Liquids taken from inoculation swelling. See microscopic drawing, fig. 4.
27	6 p. m	103	
28	9 a. m	101.75	
28	6 p. m	103.5	
29	9 a. m	101	
29	6 p. m	103.5	
30	9 a. m	102	
30	6 p. m	104	
31	9 a. m	102	
31	6 p. m	105	Had several fits of coughing.
Aug. 1	9 a. m	102	
1	6 p. m	105	
2	9 a. m	102.75	
2	6 p. m	103.5	Weather set in cold.
3	9 a. m	101.25	Cold and wet.
3	6 p. m	103	Do.
4	9 a. m	100	Do.
4	6 p. m	103.25	
5	9 a. m	101	
5	6 p. m	103	
6	9 a. m	102	
6	6 p. m	104	
7	9 a. m	101.5	
7	6 p. m	103.5	
8	9 a. m	101	
8	6 p. m	103	
9	9 a. m	105	
9	6 p. m	104.75	
10	9 a. m	102	
10	6 p. m	104.75	
11	9 a. m	102.75	
11	6 p. m	103.75	Purges.
12	9 a. m	102	
12	6 p. m	103.25	
13	9 a. m	102.5	
13	6 p. m	103.75	
14	9 a. m	102.25	Pus from inoculation swelling has rods (bacillus) without motion.
14	6 p. m	102.5	Inoculated on No. 3.
15	9 a. m	100.5	Cold and showery.
15	6 p. m	103.25	
16	9 a. m	100	Cold and dry.
16	6 p. m	103.5	
17	9 a. m	101	Cold.
17	6 p. m	104	
18	9 a. m	102.5	Cold, threatening.
18	6 p. m	103.5	
19	9 a. m	102.25	Wet and warm.
19	6 p. m	103	
20	9 a. m	102	Wet—warm.
20	6 p. m	102.75	
21	9 a. m	102.75	Warm—muggy.
21	6 p. m	103	
22	9 a. m	102	Clear.
22	6 p. m	104	
23	9 a. m	102	
23	6 p. m	104	
24	9 a. m	102.4	

LARGE BERKSHIRE PIG, No. 2—Continued.

Date.	Time.	Body temperature.	Remarks.
1880.		°F.	
Aug. 24	6 p. m	104	
25	9 a. m	102	
25	6 p. m	102.5	
26	9 a. m	101.75	
26	6 p. m	102.75	
27	9 a. m	102	
27	6 p. m	102.75	
28	9 a. m	102.5	
28	6 p. m	104.75	
29	9 a. m	102.75	
29	6 p. m	104	
30	9 a. m	102.5	
30	6 p. m	104	
31	9 a. m	102	
31	6 p. m	103.5	
Sept. 2	9 a. m	102.25	Inoculated with virus from sick pig in North Carolina; kept three days in wheat bran.
2	6 p. m	103.5	
3	9 a. m	102	
3	6 p. m	103	
4	9 a. m	102.25	
4	6 p. m	103.5	
5	9 a. m	102	Slight swelling where inoculated.
5	6 p. m	102.5	
6	9 a. m	102	
6	6 p. m	102.75	
7	9 a. m	102.25	
7	6 p. m	103	
8	9 a. m	102	
8	6 p. m	103	
9	9 a. m	102	
9	6 p. m	103.25	
10	9 a. m	102.25	
10	6 p. m	102.75	
18	6 p. m	104	Dull. Has purged and been irritable during the last week. Inoculated right ear with drop of virus, partly septic, from Camden, N. J.
19	9 a. m	103	
19	6 p. m	104	
20	9 a. m	102.5	Slight swelling where inoculated.
20	6 p. m	104.25	
21	9 a. m	102	
21	6 p. m	103	
22	9 a. m	101	
22	6 p. m	102	
23	9 a. m	101.5	
23	6 p. m	102	
24	9 a. m	101	Slight oozing where last inoculated.
24	6 p. m	102	
25	9 a. m	100.5	Feeds less than before inoculation.
25	6 p. m	102.75	
26	9 a. m	100	
26	6 p. m	102	
27	9 a. m	100.5	
27	6 p. m	102	
28	9 a. m	100	
28	6 p. m	100	
29	9 a. m	100.5	
29	6 p. m	101.5	
31	9 a. m	100	
31	6 p. m	101	
Oct. 1	9 a. m	100.25	
1	6 p. m	101	
2	9 a. m	101	Appetite fails.
2	6 p. m	103	
3	9 a. m	102.5	
3	6 p. m	104	Black circular spots inside the thighs; leave slight abrasions where scraped off.
4	9 a. m	102	
4	6 p. m	103	
5	9 a. m	100	
5	6 p. m	101	
6	9 a. m	100	
6	6 p. m	101	
7	9 a. m	100	
7	6 p. m	100	
8	9 a. m	100.05	
8	6 p. m	101.75	
9	9 a. m	101	
9	6 p. m	101.75	

LARGE BERKSHIRE PIG, No. 2—Continued.

Date.	Time.	Body temperature.	Remarks.
1880.		°F.	
Oct. 10	9 a. m	101	
10	6 p. m	102.5	
11	9 a. m	100	
11	6 p. m	101	
12	9 a. m	100	
12	6 p. m	100	
13	9 a. m	99	
13	6 p. m	99.5	
14	9 a. m	100	
14	6 p. m	101	
15	9 a. m	102	
15	6 p. m	102	
16	9 a. m	100	
16	6 p. m	101	
17	9 a. m	100	
17	6 p. m	100	
18	9 a. m	99.5	
18	6 p. m	100	
19	9 a. m	100	
19	6 p. m	100	
20	9 a. m	99	
20	6 p. m	99.5	
21	9 a. m	100	
21	6 p. m	101	
22	9 a. m	100	
22	6 p. m	100.5	
23	9 a. m	100	
23	6 p. m	100.75	
24	9 a. m	101	
24	6 p. m	101	
25	9 a. m	100	
25	6 p. m	101	
26	9 a. m	101	
26	6 p. m	101	
27	9 a. m	101	
27	6 p. m	101.75	
28	9 a. m	100	
28	6 p. m	100	
29	9 a. m	100	
29	6 p. m	100.25	
30	9 a. m	100	
30	6 p. m	101	
31	9 a. m	99.5	
31	6 p. m	100	
Nov. 1	9 a. m	99	
1	6 p. m	100	
2	9 a. m	99	
2	6 p. m	100	
3	9 a. m	99.5	
3	6 p. m	100.5	
4	9 a. m	100	
4	6 p. m	101	Ravenous.
5	9 a. m	100	
5	6 p. m	100.5	
6	9 a. m	100	
6	6 p. m	100	
7	9 a. m	99.5	
7	6 p. m	100	
8	9 a. m	100	
8	6 p. m	100.5	
9	9 a. m	100.5	
9	6 p. m	101	
10	9 a. m	100	
10	6 p. m	100.5	
11	9 a. m	99.5	Costive.
11	6 p. m	100	
12	9 a. m	99	
12	6 p. m	100	
13	9 a. m	98.5	
13	6 p. m	99.75	
14	9 a. m	98	Medicine has opened bowels.
14	6 p. m	98	
15	9 a. m	97	
15	6 p. m	98	
16	9 a. m	95	
16	6 p. m	95	
17	9 a. m	95	
17	6 p. m	98	
18	9 a. m	95	Very cold. Feeds very poorly.

LARGE BERKSHIRE PIG NO. 2—Continued.

Date.	Time.*	Body temperature.	Remarks.
1880.		° F.	
Nov. 18	6 p. m	98	
19	9 a. m	95	
19	6 p. m	95	
20	9 a. m		
20	6 p. m		
21	9 a. m		
21	6 p. m		
22	9 a. m		
22	6 p. m		
23	9 a. m		
23	6 p. m		
24	Noon		Found dead.

LARGE BERKSHIRE PIG, NO. 2.

Before his death, on the morning of November 24, this pig manifested symptoms of acute delirium, screaming in the most violent manner when approached, and attempting to bite. The eyes were congested and the muscular control very imperfect, the animal lying on its side and struggling.

The body is well nourished and the subcutaneous fat is in many places one inch to one inch and a half thick.

The *skin* has dark brown spots of the usual exudate, but no well marked purple patches. The tips of the ears are stiff, as if they had been bloodless and frozen before death.

Tongue and *pharynx* natural; the latter contains some white, tenacious, stringy mucus.

Guttural lymphatic glands moderately pigmented, and of a darkish gray.

Lungs healthy. The right lung is the seat of hypostatic congestion, evidently *post-mortem.*

Heart normal.

Stomach full, with its contents baked and closely adherent to the mucous membrane as if the organ had been inactive and digestion suspended for some time. The acidity of the contents is strongly marked. The gastric mucous membrane has bright red spots from one to two lines in diameter, especially on the great curvature and near the pylorus, but no distinct abrasions or ulcers.

Small intestines empty; slightly congested; what little ingesta is present is abnormally dry and adherent to the mucous membrane. At the commencement of the duodenum is a dark green mass of biliary matter, solid in consistency, but not dry.

Large intestines: Cæcum filled with hard, round pellets, firmly adherent to the mucous membrane, which is black on the surface, but not thickened, corrugated, nor ulcerated.

Colon in its anterior part has its contents somewhat softer and more natural. These are not formed into balls. Evidently this viscus has been recently functionally active, while the cæcum has been quite torpid or struck with atomy.

The terminal part of the colon and the rectum have firmer contents formed into balls, but not firmly adherent to the mucous membrane as in the cæcum. Spots of congestion appear along the whole length of the large intestine, but no thickening, corrugation, ulceration, nor other sign of long-continued disease.

The mesenteric and sublumbar lymphatic glands are of a pale brownish yellow hue, neither enlarged nor visibly pigmented.

Liver soft, rather friable, and of a dark purple brown.

The gall-bladder is full of a liquid bile of a dark green color.

Spleen full, well developed, and not excessively gorged with blood.

Kidneys normal.

Brain: Coverings deeply congested, especially at the base, but with little or no exudation. The gray matter of the brain seems abnormally red, and the puncta vasculosa are numerous and well marked. No indication of softening could be detected.

REMARKS.

Although this pig finally died of phrenites, its case is one of deep interest in conection with the swine plague. It had contracted the plague before coming into my possession, and was already recovering when

sent to me. For five months and a half I kept it exposed to the contagion of hog cholera, first by a cohabitation for six weeks with a sick and dying pig, then by continual confinement in the infected pen, and finally by four successive inoculations with the most potent virus I could obtain. Counting an exposure of a fortnight in the original diseased herd before he came into my hands, this pig was constantly exposed to the infection in a concentrated form for a period of six months. Of the inoculations in the course of this experiment, the two first were of a large and therefore specially dangerous amount of the virulent fluid injected under the skin; the third was a similar injection of the liquid virus which had been cultivated in wheat bran—a cultivation which, in my former experiments upon unprotected pigs, has always acted with deadly effect; and the fourth and last inoculation was with a slightly septic liquid, so that the pig was subjected to the risk of septicæmia as well as the genuine swine plague.

Chauveau has shown, as already stated, that in the related bacteridian disease, *anthrax*, while an animal can be protected by a first attack against the effects of an ordinary exposure to infection, and against inoculation with small quantities of the virus, that this immunity does not usually stand the test of a subcutaneous injection with a large amount of the liquid virus. Chauveau's experiments are so conclusive that they may be quoted:

1st. In a first series of experiments he made several small punctures on the inside of the ear with the point of a lancet charged with the virus. In this manner but a minimum quantity of virus was introduced. Six robust European sheep inoculated in this way all perished, whereas seven Algerian sheep showed not the slightest ill results from the operation.

2d. A second lot of four Algerian sheep were inoculated in the ear by a lancet charged with the fresh pulp of glands extremely rich in bacteria, and at the same time by injection under the skin of the thigh of a cultivated liquid rich in the *bacillus anthracis*. Three days later they were again inoculated by the hypodermic injection of five or six drops of a similar infecting cultivation liquid. Three of those subjects became distinctly though slightly ill. The fourth, a pregnant ewe, died early on the seventh day after the first inoculation.

3d. The third lot consisted of eight sheep (four ewes and their lambs). They were inoculated with a cultivation liquid very rich in the spores and mycelium of *bacillus anthracis*, to which was added the liquid extracted from diseased lymphatic glands, and literally saturated with bacillus rods. It was injected under the skin of the ears in doses of five or six drops for the ewes and three or four for the lambs. One lamb showed no symptom of illness, but all the others suffered considerably, and one ewe died of anthrax eight days after the inoculation.

4th. A fourth lot, eight animals, were each inoculated by injecting under the skin a cubic centimeter of a cultivation liquid rich in anthrax spores, mixed with gland juices rich in anthrax bacilli, and the remaining eight with half the amount of the same fluid. Of these, six died of anthrax, but only one of the six belonged to the eight that had been inoculated with the small dose. The others suffered from slight dullness and inappetense, but this speedily passed, and all were fully restored to health by the sixth day.

5th. At the same time that the second lot were subjected to experiment, Chauveau submitted to the same test the seven survivors of the first experiment. It caused a slight indisposition only. A third time he inoculated these seven in the same way as the third lot, and produced again but slight illness.

This shows conclusively that animals which are proof against an ordinary dose of the anthrax poison are still unable to resist a much larger dose or a succession of large doses. If we add to this that in chicken cholera (and the bacteridian diseases) Pasteur has found that the dilution of the virus can be so conducted as to produce a mild in place of a fatal form of the affection, it is altogether reasonable to suppose that in a third bacteridian disease, as swine plague is supposed to be, the same should hold equally true.

We may assume that this pig was fortified against a second attack of the

disease by his first illness while with Mr. Frear, since a second attack, during the same season, at least, rarely occurs by reason of exposure to infection. In further proof of this we have the three inoculations with a large amount of virulent liquid, and a fourth with a more limited quantity, yet at no time did he show anything more than a slight indisposition, and he survived the last inoculation sixty-seven days, and finally died in fine condition from an accidental illness, for before death he showed mainly torpor of the liver and bowels, and finally, in connection with the sudden onset of extremely cold weather, congestion of the brain and delirium. The *post-mortem* appearances did not present the lesions of swine plague; the lymphatic glands were not enlarged nor pigmented (a very slight discoloration of the guttural excepted); the skin had none of the usual purple or leaden congestion, and the bowels showed no thickening, corrugation, erosions, nor ulcers. That the system had suffered from the action of the disease and the effects of the succession of test inoculations, added to the constant exposure in the infected pen, is strongly probable, and with the onset of winter the digestion became languid, the bowels torpid, and the final cold period which set in about November 15, and during which the temperature reached zero, brought about congestion of the brain and the fatal result.

We may assume from this case that the protection furnished by a first attack of hog cholera is relative and not absolute; that the system suffers permanently from such first attack, and even from successive exposures and inoculations, so that, although proof against any ordinary exposure to hog cholera, it is impaired in vigor, and for a time at least is more rather than less easily affected by other diseases; and, therefore, that animals so treated require increased protection against the weather or other health depressing conditions.

POLAND CHINA PIG, NO. 3.

This was a small unthrifty pig, the smallest of the litter, and the sole survivor, all the others having died of a disease supposed to have been hog cholera. It suffered besides from a nervous trouble and carried its head to one side and the neck partly twisted, so that one eye looked upward. It was also terribly infested with lice (*Hœmatopinus suis*).

Date.	Time.	Body temperature.	Remarks.
1880.		° F.	
June 26	9 a. m.	102	Costive and eats little.
27	...do	102	Had dose castor oil.
28	...do	101.5	Had passage of hardened fæces.
29	...do	101.8	Castor oil repeated.
30	...do	100.8	No passage; took a third dose of castor oil.
July 1	...do	100.7	Bowels move freely.
2	...do	101	
3	...do	100	Purging; inoculated with a cultivation of virus in milk; second generation; kept seven days in a cool room.
4	...do	100	
4	6 p. m.	100	
5	9 a. m.	103	Bowels inactive.
5	6 p. m.	99	Was roused from a deep sleep.
6	9 a. m.	100	Bowels act freely.
6	6 p. m.	101	
7	9 a. m.	101	Purges.
7	6 p. m.	101	Do.
8	9 a. m.	101	Do.
9	...do	96	Do.
9	6 p. m.	102.5	Do
10	9 a. m.	98	Do
10	6 p. m.	102	Do.
11	9 a. m.	103	Do.
11	6 p. m.	96	Do.

POLAND CHINA PIG, No. 3—Continued.

Date.	Time.	Body temperature.	Remarks.
1880.		°*F.*	
July 12	9 a. m	102.75	Purges.
13	....do	102	Do.
14	....do	99.75	Do.
15	6 p. m	103	Do.
16	....do	99	Do.
17	9 a. m	100.5	Do.
17	6 p. m	99.5	Do.
18	9 a. m	100	Dying; breathing in gasps.
18	Noon	....	Dead.

POST-MORTEM EXAMINATION, JULY 19, 1880.

The day being cold the body was left till next day (Monday), at which time it showed few traces of decomposition. The body was considerably emaciated, the skin thin and bloodless, without observable petechiæ, and with little of the black exudation. Blood dropped from the nostrils. There was no swelling or slough in the seat of inoculation.

The *blood* formed a loose clot.

The *inguinal glands* were small and nearly natural.

The *prethoracic* and *guttural lymphatic glands* were pigmented of a dark gray color.

The *right lung* was deeply reddened and gorged with blood, evidently a hypostatic congestion, and mostly post-mortem.

The *left lung* natural.

The *aortic lymphatic glands* were congested of a very deep red.

Stomach: The mucous membrane on the great curvature was of a deep red, with several black spots on blood extravasation, from one-half to one line in diameter, on the margins of the fold.

Spleen and *liver* seemed normal.

Intestines: Slightly congested. No ulcers were detected.

The *mesenteric glands* were enlarged, and, like the aortic, of a deep red color.

REMARKS.

The death of this pig serves to corroborate the conclusions deduced from the results in No. 1, that the introduction of new virus into a system at the time under the influence of swine-plague only serves to hasten a fatal result. It affords strong presumptive evidence that a first attack is only protection against a second, if the active effects of the first illness have completely subsided and convalescence completed.

LARGE WHITE PIG, No. 4.

This pig was only four weeks old, it having been found difficult at the time to procure subjects of a more suitable age. Together with its fellow, it suffered seriously from the sudden change from the milk of its dam to other food, and from the complaint.

Date.	Time.	Body temperature.	Remarks.
1880.		°*F.*	
June 27	9 a. m	103	
28	....do	104	
29	....do	102	
30	....do	101.5	
July 1	....do	102	
2	....do	102	
3	....do	101.5	Inoculated with cultivation of virus in egg-albumen; second generation; had been seven days in the apparatus. See microscopic drawing, Fig. 5.

LARGE WHITE PIG, No. 4—Continued.

Date.	Time.	Body temperature.	Remarks.
1880.		°F.	
July 4	....do	101	Bowels loose.
4	6 p. m	101.5	Purging.
5	9 a. m	102	Do.
5	6 p. m	102.5	Do.
6	9 a. m	103.5	
6	6 p. m	101	
7	9 a. m	103	
7	6 p. m	103	
8	9 a. m	101.5	
9	....do	102	
9	6 p. m	105	
10	9 a. m	103	Inoculated with peritoneal exudation from North Carolina; kept in vacuum tube for eight days. See microscopic drawing, Fig. 6.
10	6 p. m	105.4	
11	9 a. m	105.4	
11	6 p. m	105	
12	9 a. m	103.5	
13	....do	103	
14	....do	102.75	
15	....do	104.3	
16	....do	104	
17	....do	100	Fæces fœtid.
17	6 p. m	102	
18	9 a. m	101.75	
18	6 p. m	102.75	
19	9 a. m	102	
19	6 p. m	104	
21	9 a. m	102	
22	....do	104	
22	6 p. m	102	
23	9 a. m	102	
23	6 p. m	103.75	
24	9 a. m	103.5	
24	6 p. m	104	
25	9 a. m	101.75	Anus tender: thermometer perhaps not long enough inserted.
25	6 p. m	104.5	
26	9 a. m	102	Rectum irritable and contracted.
26	6 p. m	103.5	Do.
27	9 a. m	102.5	Do.
27	6 p. m	104	Do.
28	9 a. m	102	Skin and bristles harsh.
28	6 p. m	103	
29	9 a. m	101.75	
29	6 p. m	103.5	
30	9 a. m	102	
30	6 p. m	104	Skin harsh, itchy.
Aug. 1	9 a. m	101	
1	6 p. m	105	
2	9 a. m	103	
2	6 p. m	102.75	Weather very cold.
3	9 a. m	101	Cold and wet.
3	6 p. m	101.5	Do.
4	9 a. m	101	Do.
4	6 p. m	103	Do.
5	9 a. m	100	
5	6 p. m	102.5	
6	9 a. m	101	
6	6 p. m	104.75	
7	9 a. m	99.5	
7	6 p. m	104	
8	9 a. m	100.5	
8	6 p. m	104.75	
9	9 a. m	103.5	
9	6 p. m	104.75	
10	9 a. m	100	
10	6 p. m	104.75	Placed in pen with convalescent pig, No. 2.
11	9 a. m	103.5	
11	6 p. m	104	
12	9 a. m	101.75	
12	6 p. m	103.75	Returned to its former pen.
13	9 a. m	101	Inoculated with dried virus, sent on quill from North Carolina, July 2.
13	6 p. m	104	
14	9 a. m	101	
14	6 p. m	104	
15	9 a. m	100	Weather cold, showery; slight swelling where last inoculated.

LARGE WHITE PIG, No. 4—Continued.

Date.	Time.	Body temperature.	Remarks.
1880.		°F.	
Aug. 15	6 p. m	102.5	
16	9 a. m	100	Cold, dry.
16	6 p. m	102.5	
17	9 a. m	101	
17	6 p. m	104.5	Cold.
18	9 a. m	102.5	
18	6 p. m	104	
19	9 a. m	103.5	Wet, warm.
19	6 p. m	103.75	
20	9 a. m	101	Warm, wet.
20	6 p. m	103.5	
21	9 a. m	103	Warm, muggy.
21	6 p. m	103.75	
22	9 a. m	101.75	
22	6 p. m	103.75	
23	9 a. m	102	
23	6 p. m	104.75	
24	9 a. m	102.75	
24	6 p. m	104	
25	9 a. m	101	
25	6 p. m	101	
26	9 a. m	101	
26	6 p. m	103	
27	9 a. m	101.5	
27	6 p. m	103.75	
28	9 a. m	101	
28	6 p. m	102	
29	9 a. m	101.5	
29	6 p. m	102.5	
30	9 a. m	101	Cold, wet.
30	6 p. m	102	
31	9 a. m	101	
31	6 p. m	102	
Sept. 2	9 a. m	101	
2	6 p. m	103	
3	9 a. m	102	
3	6 p. m	104	Inoculated with matter from North Carolina, that had been cultivated three days in wheat bran.
4	9 a. m	102.5	
4	6 p. m	104.75	
5	9 a. m	102.5	
5	6 p. m	104	
6	9 a. m	102.75	
6	6 p. m	104	
7	9 a. m	102.5	
7	6 p. m	103.75	
8	9 a. m	102	
8	6 p. m	104	
9	9 a. m	102.25	
9	6 p. m	103.75	
10	9 a. m	102	
10	6 p. m	104	
18	....do	103	Inoculated with virus from New Jersey, sent in liquid form and slightly putrid.
19	9 a. m	102	
19	6 p. m	103.5	
20	9 a. m	101.5	
20	6 p. m	102.75	
21	9 a. m	101.5	
21	6 p. m	102.5	
22	9 a. m	101	
22	6 p. m	102	
23	9 a. m	101	
23	6 p. m	102.5	
24	9 a. m	100	
24	6 p. m	101	
25	9 a. m	101	
25	6 p. m	102	
26	9 a. m	100	
26	6 p. m	101	
27	9 a. m	100.5	
27	6 p. m	101	
28	9 a. m	100	
28	6 p. m	99	Will not rise; has convulsive jerkings.
29			Found dead this morning.

POST-MORTEM EXAMINATION.

Dissection made on the forenoon of September 29.

Condition of body:—Emaciated, skin thin, bloodless, deficient in subcutaneous fat, and covered with much dark scurf. Dark purple blotches appear on the ears, submaxillary space, neck, breast, abdomen, and inner sides of the limbs. Pressure causes the momentary disappearance of each plaque, but leaves a number of ineffaceable purple points. There are hard subcutaneous swellings in the seat of the successive inoculations. One of these in the right flank has an outer layer of a dark blue fibroid appearance, within which is a firm layer of a dirty yellow aspect, and in the center a brownish-white creamy liquid. The latter appears to have resulted from the breaking down of the primary hard induration, while the inner yellow layer of the wall is in progress towards such disintegration. The liquid, when placed under the microscope with a magnifying power of 250 diameters, shows the object figured in microscopic drawing, Fig. 7, none of them magnifying automatic movements.

The *lymphatic glands, superficial, inguinal,* and *pharyngeal,* were of a deep red; the *internal, inguinal,* and *sublumbar* pigmented of a dark gray.

The *tonsils* contain yellowish cheesy products distending their follicles.

The *lungs* are natural, the *kidneys* sound; *spleen* normal.

The *liver* has, at intervals, purple plaques and patches. The *bile* is glutinous, of a dark orange-green color. The *common bile duct* is blocked by a large worm (*Ascaris suilla*), twelve inches long and bent upon itself. The bile duct leading into the right lobe contains a smaller *ascaris:*

Stomach:—The mucous membrane on the great curvature is of a deep brownish-red, more or less mottled. At intervals are minute depressions as if from dilated glands or loss of substance. Close in front of the pylorus are several ulcers, with bright yellow base and ragged non-projecting edges, surrounded by a pink areola. These are mostly under a line in diameter, but one has an extent of an inch and a half by one-sixth of an inch, evidently caused by the confluence of several smaller ones.

The *small intestines* and *mesentery* are deeply congested throughout. The *ilium* is filled with dark liquid blood, and its mucous membrane is much thickened and softened. (See Plate I.) A portion of the ilium is greatly distended by *ascarides,* and an adjacent portion has become invaginated to the extent of two inches into the end of the dilated portion, completely blocking its channel. (See Plate II.)

The *large intestines* are congested, and at intervals blood has been effused into their lumen.

The bowels contain twenty-four *ascarides,* varying in length from nine inches to a foot. The cæcum and colon contain a few whip-worms (*Tricocephalus dispar*).

REMARKS.

This pig had a specially hard experience, having been removed from its dam at an early age and at once subjected to a new, unwonted diet, and the action of the swine plague. As judged by the final result, it appears to show that the virus, as modified by cultivation in egg albumen, is no protection against a subsequent inoculation with a large amount of the native virus, or that which has had its potency increased by cultivation in wheat bran. Yet the early results were quite encouraging. The subject successfully resisted an inoculation with the virulent peritoneal exudate, though made only seven days after the first with a cultivation in egg albumen; also exposure to an infected pen, and inoculated from a quill smeared with the dried virus, and only perished forty-six days after, and when it had been reinoculated two more times with a drachm of a cultivation of the virus in bran, and two weeks later with a drachm of slightly putrid virus from a bad case of the plague. The question of using this septic virus was a delicate one, but considering that I could rarely secure fresh virus from sources outside my own experiments, and as hogs kept in the usual way must be constantly subjected to the risk of septic infection from sores on their bodies, I decided to put this to the test. The fatal result arrived after the use of three large injections of virulent matter, which I have since learned are often sufficient to overcome the power of resistance acquired from a first attack, and which are therefore to be avoided in future experiments. Another important point is that in this case the direct cause of death

was the invagination of the intestine, and as this was a mere accidental result of the irritation of the bowels, it is possible that but for this the patient might have survived even the later and more severe inoculations.

SMALL WHITE PIG, No. 5.

This pig was from the same litter with No. 4, and had all its disadvantages, together with the fact of its smaller size and somewhat less thrift.

Date.	Time.	Body temperature.	Remarks.
1880.		°F.	
June 27	9 a. m	102.5	Lively, well.
28	....do	103	
29	....do	102	
30	....do	103	
July 1	....do	102	
2	....do	101	
3	....do	101.5	Inoculated with virus (lung exudate from sick pig at Horseheads) cultivated in human urine to second generation. Has been in apparatus 7 days. (See Microscopic Drawings, Fig. 8.)
4	....do	103	
4	6 p. m	103	Purges.
5	9 a. m	102	Do.
5	6 p. m	103	Do.
6	9 a. m	103.5	Do.
6	6 p. m	104	Do.
7	9 a. m	103.7	Do.
7	6 p. m	103.5	
8	9 a. m	102	
9	....do	102	
9	6 p. m	104.5	
10	9 a. m	103	Inoculated hypodermically ½ drachm peritoneal exudate of sick pig, kept 8 days in a vacuum tube, and sent from North Carolina. (See Microscopic Drawings, Fig. 6.)
10	6 p. m	104.9	
11	9 a. m	104.9	
11	6 p. m	103	
12	9 a. m	103.75	
13	....do	103	
14	....do	102.5	
15	6 p. m	103	
16	....do	102.5	
17	9 a. m	101.5	Skin covered with a black, greasy exudation, and itchy.
17	6 p. m	102.5	
18	9 a. m	103.5	
18	6 p. m	103	
19	9 a. m	101.75	
19	6 p. m	104	
21	9 a. m	100	
22	....do	104	
22	6 p. m	100	
23	9 a. m	102	
23	6 p. m	103	
24	9 a. m	101.25	
24	6 p. m	104	
25	9 a. m	103	
25	6 p. m	104.5	
26	9 a. m	101.5	
26	6 p. m	104	
27	9 a. m	101.5	
27	6 p. m	104	
28	9 a. m	103	Rectum has been irritable and contracted for several days.
28	6 p. m	104	Skin covered with a black exudation; bristles harsh.
29	9 a. m	102.75	
29	6 p. m	102.5	
30	9 a. m	102	
30	6 p. m	102.5	
31	9 a. m	101.25	
31	6 p. m	103	
Aug. 1	9 a. m	101	
1	6 p. m	104	
2	9 a. m	102	

SMALL WHITE PIG, No. 5—Continued.

Date.	Time.	Body temperature.	Remarks.
1880.		°F.	
Aug. 2	6 p. m.	103	Set in cold.
3	9 a. m	101	Cold and wet.
3	6 p. m.	101.5	Do.
4	9 a. m	101	Do.
4	6 p. m.	102.5	Do.
5	9 a. m	100	
5	6 p. m.	102.5	
6	9 a. m	102	
6	6 p. m.	104.75	
7	9 a. m	99.5	
7	6 p. m.	104	
8	9 a. m	101	
8	6 p. m.	104.25	
9	9 a. m	103	
9	6 p. m.	104.5	
10	9 a. m	100.5	
10	6 p. m.	104.5	Placed in infected pen with No. 2.
11	9 a. m	103.5	
11	6 p. m.	103.5	
12	9 a. m	103.25	
12	6 p. m.	103.75	Returned to its former pen.
13	9 a. m	100	Inoculated with dried virus on quill sent from North Carolina, July 2. Also, with 1 drachm of infusion of decomposing maize, the latter hypodermically.
13	6 p. m.	103.75	
14	9 a. m	102.5	
14	6 p. m.	103.75	
15	9 a. m	102	Weather cold, showery. Swelling an inch in diameter where inoculated with the corn solution.
15	6 p. m.	102	
16	9 a. m	100	Cold, dry.
16	6 p. m.	103.5	
17	9 a. m	99	Cold.
17	6 p. m.	102.75	
18	9 a. m	103	Cold, threatening.
18	6 p. m.	102.5	
19	9 a. m	103	
19	6 p. m.	103.75	
20	9 a. m	102	Warm, wet.
20	6 p. m.	103.5	
21	9 a. m	103	Muggy, warm.
21	6 p. m.	103.75	
22	9 a. m	101.5	Clear.
22	6 p. m.	104	
23	9 a. m	102	
23	6 p. m.	104.25	Hot.
24	9 a. m	103.5	
24	6 p. m.	104	
25	9 a. m	101.[illegible]	
25	6 p. m.	101.75	
26	9 a. m	101	
26	6 p. m.	102	
27	9 a. m	101.5	
27	6 p. m.	103.5	
28	9 a. m	102	
28	6 p. m.	103	
29	9 a. m	101	
29	6 p. m.	102.5	
30	9 a. m	101	Cold, wet
30	6 p. m.	102.5	
31	9 a. m	101	
31	6 p. m.	102.25	
Sept. 2	9 a. m	101	
2	6 p. m.	103	
3	9 a. m	102.5	Inoculated with virus cultivation in wheat-bran 1 drachm of infusion injected under the skin.
3	6 p. m.	104	
4	9 a. m	102	
4	6 p. m.	104.5	
5	9 a. m	102	
5	6 p. m.	103.25	
6	9 a. m	102	
6	6 p. m.	103.75	
7	9 a. m	101.5	
7	6 p. m.	103.5	
8	9 a. m	102	
8	6 p. m.	103.75	

SMALL WHITE PIG, No. 5—Continued.

Date.	Time.	Body temperature.	Remarks.
1880.		° F.	
Sept. 9	9 a. m	101	
9	6 p. m	103. 5	
10	9 a. m	101. 75	
10	6 p. m	103	
18	... do	102	Inoculated with virulent peritoneal exudation slightly putrid. One drachm injected under the skin.
19	9 a. m	101	
19	6 p. m	102. 25	
20	9 a. m	101. 5	
20	6 p. m	102	
21	9 a. m	101. 75	
21	6 p. m	103	
22	9 a. m	101. 5	
22	6 p. m	102	
23	9 a. m	101. 5	
23	6 p. m	102. 5	
24	9 a. m	100	
24	6 p. m	101	
25	9 a. m	101	
25	6 p. m	101	
26	9 a. m	100	
26	6 p. m	101	
27	9 a. m	101	
27	6 p. m	101. 5	
28	9 a. m	101	
28	6 p. m	102	
29	9 a. m	101	
29	6 p. m	101. 5	
30	9 a. m	99	
30	6 p. m	100	
Oct. 1	9 a. m	98	
1	6 p. m	99	
2			Died this morning.

POST-MORTEM EXAMINATION, OCTOBER 2—AFTERNOON.

Body badly emaciated, skin thin and bloodless, bluish discoloration beneath the breast-bone and on the hocks.

Inguinal lymphatic glands enlarged (especially the eighth) and pigmented. *Sublumbar lymphatic glands* not much affected. *Guttural lymphatic glands* congested and of a deep red. *Paroted lymphatic gland* pigmented gray. Abscess in the right flank in the seat of the last inoculation, with fetid contents.

Thyroid body enlarged.

Left lung has congested lobulettes of a dark red (almost black) color. The anterior lobe is carnified.

Right lung has the anterior lobe consolidated, and a section shows a deep red surface studded with white points.

Miliary tubercle. (See Plate III, Fig. 1.)

Liver large, black, very soft and friable.

Spleen normal.

Stomach contains a fair amount of ingesta and the mucous membrane covering the great curvature presents considerable thickening with dark brown discoloration. (See Plate III, Fig. 2.)

Small intestine is almost empty, but little altered.

Cæcum has its mucous membrane thickened, corrugated, and of a greenish black color, with red points at intervals. It contains many whipworms (*Tricocephalus dispar*) with their heads burrowed in the mucous membrane.

The *kidneys* are normal.

REMARKS.

This pig, though originally young and weak, and though subjected to a severe change of regimen at the commencement of the experiments, survived three successive inoculations and only succumbed in the end under the excessive hypodermic injections of infusion of virulent wheat bran and of slightly putrid virus. It failed in flesh from the first, a

fact which may be largely accounted for by the pulmonary tuberculosis found after death. At the same time it is not impossible that this was a recent development from the last inoculation with semi-putrid matter, as happened repeatedly to Burdon-Sanderson in his experiments on Septicæmia.

The case seems to show that while a cultivation of the virus in acid urine may protect against a moderate exposure to infection, it is powerless to prevent untoward results in case of large injections of specially virulent matter, and above all if to such matter the septic poison is added.

BERKSHIRE PIG NO. 6.

Date.	Time.	Body temperature.	Remarks.
1880.		°F.	
July 10	10 a. m		Inoculated with virulent peritoneal exudation of sick pig, sent from North Carolina, in a vacuum tube which has been open 36 hours. Strong odor of hog, but not putrid.
10	7 p. m	105.2	
11	9 a. m	105.2	
11	6 p. m	103	
12	9 a. m	102.75	
13	...do	102	
14	...do	101.5	
15	6 p. m	104.2	Swelling in seat of inoculation.
16	...do	105	
17	9 a. m	101.5	Purges. Dejection fœted.
17	6 p. m	101	
18	9 a. m	102	
18	6 p. m	103.5	
19	9 a. m	102.75	
19	6 p. m	103.5	
21	9 a. m	102	
22	...do	103.5	
22	6 p. m	102	
23	9 a. m	102	
23	6 p. m	102.75	
24	9 a. m	101	
24	6 p. m	103	
25	9 a. m	103	
25	6 p. m	103	Rectum irritable, contracted.
26	9 a. m	101	
26	6 p. m	102	Rectum irritable, contracted.
27	9 a. m	102.5	
27	6 p. m	105	Rectum irritable, contracted.
28	9 a. m	102	Do.
28	6 p. m	102.25	Do.
29	9 a. m	102	Do.
29	6 p. m	104	Do.
30	9 a. m	102.75	
30	6 p. m	103.25	
31	9 a. m	101.75	
31	6 p. m	104	
Aug. 1	9 a. m	100.5	
1	6 p. m	104.25	
2	9 a. m	102	
2	6 p. m	103	Set in cold weather.
3	9 a. m	102.25	Cold and wet.
3	6 p. m	101.5	Do.
4	9 a. m	101	Do.
4	6 p. m	103	Do.
5	9 a. m	101	
5	6 p. m	102.5	
6	9 a. m	101.5	Inoculated with cultivation of the virus in milk which was seeded with the virus July 29, and has stood in a cold room. One drachm injected.
6	6 p. m	103.5	
7	9 a. m	101	Swelling in seat of inoculation.
7	6 p. m	103	
8	9 a. m	101	
8	6 p. m	104	
9	9 a. m	102	
9	6 p. m	104	
10	9 a. m	99.5	
10	6 p. m	104	
11	9 a. m	101	
11	6 p. m	103	

BERKSHIRE PIG, No. 6—Continued.

Date.	Time.	Body temperature.	Remarks.
1880.		°F.	
Aug. 12	9 a. m.	101	
12	6 p. m.	103.5	Placed in infected pen with No. 2.
13	9 a. m.	101	Removed to old pen.
13	6 p. m.	104	
14	9 a. m.	101	
14	6 p. m.	103	
15	9 a. m.	101.5	
15	6 p. m.	102.5	Cold, showery.
16	9 a. m.	101.75	Cold, dry.
16	6 p. m.	103.5	
17	9 a. m.	102.5	Cold.
17	6 p. m.	102.75	
18	9 a. m.	101.25	Cold, threatening.
18	6 p. m.	102.75	
19	9 a. m.	102.5	Warm, rain.
19	6 p. m.	103	
20	9 a. m.	101	Warm, rain. Coughs.
20	6 p. m.	101	
21	9 a. m.	103.5	Muggy.
21	6 p. m.	102	
22	9 a. m.	102.5	Clear.
22	6 p. m.	103.5	
23	9 a. m.	102.5	
23	6 p. m.	104	Hot.
24	9 a. m.	101	
24	6 p. m.	104.5	Hot.
25	9 a. m.	102	
25	6 p. m.	102.25	
26	9 a. m.	101.75	
26	6 p. m.	103	
27	9 a. m.	101.5	
27	6 p. m.	103	
28	9 a. m.	101.75	
28	6 p. m.	103	
29	9 a. m.	101.75	
29	6 p. m.	103	
30	9 a. m.	101.5	Cold, wet.
30	6 p. m.	102.5	
31	9 a. m.	101.5	
31	6 p. m.	103	
Sept. 2	9 a. m.	101.25	
2	6 p. m.	102.75	
3	9 a. m.	102	Inoculated by hypodermic injection of one drachm of infusion of bran, inoculated with virus three days before.
3	6 p. m.	104.5	
4	9 a. m.	102.5	
4	6 p. m.	104.75	Hot.
5	9 a. m.	102	Thunderstorm.
5	6 p. m.	103	Cooler.
6	9 a. m.	102	
6	6 p. m.	103.5	
7	9 a. m.	102.25	
7	6 p. m.	103	
8	9 a. m.	102	
8	6 p. m.	103.5	
9	9 a. m.	102.25	
9	6 p. m.	103.25	
10	9 a. m.	102	
10	6 p. m.	103	
18	...do.	103	Has been very sick for the past week, but seems improving, though purging. Inoculated with virulent peritoneal exudation from sick pig in New Jersey, sent as a liquid and slightly putrid.
19	9 a. m.	102	
19	6 p. m.	103	
20	9 a. m.	102.5	
20	6 p. m.	103.5	
21	9 a. m.	102.5	Dull. Skin very unthrifty; scurfy.
21	6 p. m.	103.75	Is stiff behind and very lame in the near hind leg.
22	9 a. m.	102.25	
22	6 p. m.	103.75	
23	9 a. m.	102	
23	6 p. m.	102.5	
24	9 a. m.	102	
24	6 p. m.	103	
25	9 a. m.	101	Very dull. Crouches with back raised, scours, fæces liquid with solid floating particles. Rectum irritable, contracted.

BERKSHIRE PIG, No. 6—Continued.

Date.	Time.	Body temperature.	Remarks.
1880.		°F.	
Sept. 25	6 p. m	102.5	
26	9 a. m	101	
26	6 p. m	102	
27	9 a. m	101.5	
27	6 p. m	103	
28	9 a. m	101	
28	6 p. m	102.5	
29	9 a. m	102	Dull, crouches; rectum tender, purges.
29	6 p. m	103.25	
30	9 a. m	102	
30	6 p. m	103	
Oct. 1	9 a. m	102.5	
1	6 p. m	103.25	
2	9 a. m	102	
2	6 p. m	103	
3	9 a. m	102.5	
3	6 p. m	103	
4	9 a. m	102	Dull; purges.
4	6 p. m	103	
5	9 a. m	100	
5	6 p. m	102	
6	9 a. m	102	
6	6 p. m	103	
7	9 a. m	101	
7	6 p. m	102	
8	9 a. m	101	
8	6 p. m	102	
9	9 a. m	102	
9	6 p. m	104	
10	9 a. m	102	
10	6 p. m	103.5	
11	9 a. m	102.5	
11	6 p. m	103	
12	9 a. m	101	Purges.
12	6 p. m	102.5	
13	9 a. m	100	Does not rise. Ears cold and blue.
13	6 p. m	101	
14	9 a. m	99	
14	6 p. m	100	
15	9 a. m	99	
15	6 p. m	100	
16	9 a. m	99	
16	6 p. m	100	
17	9 a. m	100	
17	6 p. m	101	
18	9 a. m	98	
18	6 p. m	98	
19	....	....	Found dead this morning. Still warm.

POST-MORTEM EXAMINATION, 3 P. M. SAME DAY.

Skin on the snout, lips, ears, forearm, thighs, and to a less extent on the abdomen, of a deep red, marked even on the black skin. These discolored portions are found on section to be of a dark red throughout the whole thickness, the result of a capillary engorgemet, stasis, and extravasation, as shown on microscopic examination. In the right flank, in the seat of inoculations, are two firm, rounded masses, each about ¾ inch in diameter, situated in the subcutaneous connective tissue, and consisting of a pus-like fluid, inclosed in thick fibroid walls. The liquid is not fœtid.

The superficial inguinal glands are greatly enlarged and of a deep red throughout.

The *tongue* has its papillæ enlarged, and on the margins near its anterior extremity spots slightly raised and abraded in the center.

The *guttural* and *prepectoral glands* are enlarged and congested, of a very dark red.

The *heart* on the right side contains a firm clot, mostly buffy. That in the auricle and venæ cavæ may be said to be almost destitute of red globules.

The left side of the *heart* contains a similar but smaller clot. The septum ventriculorum on this side bears several dark red petechiæ.

Lungs normal.

Internal inguinal sublumbar and *mesenteric lymphatic glands* are enlarged and of a deep red color.

Kidneys and *spleen* normal.

Stomach contains a considerable amount of undigested food. The mucous membrane is in a natural condition.

Small intestine little altered; contains twelve large worms (*Ascaris suilla*).
Large intestine is slightly congested, with petechiæ and enlarged follicles.
Liver is variously colored. Parts are of a light brownish-yellow and parts of a dark purplish-red. All very friable. The gall bladder is partly filled with dark-green bile. The common bile duct is filled by a large *ascaris*, which projects into the duodenum and extends beyond the cystic duct into the biliary duct and liver. These distended ducts are somewhat red and congested.

REMARKS.

This pig was first employed as a test case of the virulence of the North Carolina virus sent in a vacuum tube. The inoculation with this material produced a moderate though distinct attack of swine plague, from which the animal recovered so that it ought to have been as well fortified against a second attack as if it had contracted the disease in the ordinary way. Four weeks after the first inoculation the patient was again inoculated, this time with milk, on which the virus had been sown and cultivated for eight days. Though a drachm of this liquid had been injected, there seemed to be little effect beyond the occurrence of a swelling in the seat of inoculation. Six days later it was placed over night in an infected pen along with a convalescent pig. These having proved apparently harmless, the patient was injected with a drachm of virulent liquid from an inoculated bran infusion. As in the case of other pigs, this produced a smart attack of the disease, but in two weeks it seemed improving and was again injected with ½ drachm of virulent and slightly putrid peritoneal exudation. From this time onward its illness was continuous, and it steadily sank, though it survived the last inoculation four weeks in all.

The case is interesting as showing the power of resistance of the convalescent animal to inoculation with a large amount of infected milk, and also to the confinement in an infected pen, but it is none the less so as corroborating the other cases in showing that this acquired insusceptibility was broken down before a large injection of virulent infusion of wheat bran, and of the same amount of peritoneal exudation of a bad case of hog cholera.

Female Berkshire Pig, No. 7.

Date.	Time.	Body temperature.	Remarks.
1880.		°F.	
July 27	6 p. m.	105	
28	9 a. m.	103.25	
28	6 p. m.	103	
29	9 a. m.	104	Inoculated with milk that had been charged with virus two days previous, but by accident had been raised to at least 120° F. See Microscopic Drawings, Fig. 9.
29	6 p. m.	103.75	
30	9 a. m.	104	
30	6 p. m.	104.5	
31	9 a. m.	103.75	
31	6 p. m.	103	
Aug. 1	9 a. m.	103	
1	6 p. m.	106	
2	9 a. m.	103	
2	6 p. m.	105	Set in cold.
3	9 a. m.	103	Cold and wet.
3	6 p. m.	103.25	Do.
4	9 a. m.	102.75	Do.
4	6 p. m.	103.5	Do.
5	9 a. m.	101	
5	6 p. m.	103	
6	9 a. m.	102.75	Inoculated with one drachm human urine that had been infected with virulent matter July 29.

FEMALE BERKSHIRE PIG, No. 7—Continued.

Date.	Time.	Body temperature.	Remarks.
1880.		° F.	
Aug. 6	6 p. m	103.25	
7	9 a. m	100.75	
7	6 p. m	103	
8	9 a. m	101.75	
8	6 p. m	105	
9	9 a. m	103	
9	6 p. m	104.5	
10	9 a. m	102.5	
10	6 p. m	104.5	
11	9 a. m	102.5	
11	6 p. m	103.75	
12	9 a. m	103	
12	6 p. m	104	
13	9 a. m	101.5	Before fed.
13	6 p. m	104	
14	9 a. m	103	
14	6 p. m	104	
15	9 a. m	100.75	Cold, showery.
15	6 p. m	103	
16	9 a. m	100.75	Cold, dry.
16	6 p. m	104.5	
17	9 a. m	100.5	Cold.
17	6 p. m	103.25	
18	9 a. m	101	
18	6 p. m	103.5	
19	9 a. m	101	
19	6 p. m	105	
20	9 a. m	103	Warm, wet.
20	6 p. m	102.5	
21	9 a. m	102.5	Muggy.
21	9 p. m	103	
22	9 a. m	101.75	Clear.
22	6 p. m	104	
23	9 a. m	102	
23	6 p. m	104.5	
24	9 a. m	101.75	
24	6 p. m	104.25	Hot.
25	9 a. m	101.5	
25	6 p. m	102.75	
26	9 a. m	102	
26	6 p. m	103.25	
27	9 a. m	102	
27	6 p. m	103.5	
28	9 a. m	101.5	
28	6 p. m	103.5	
29	9 a. m	101.75	
29	6 p. m	103.5	
30	9 a. m	102	Cold, wet.
30	6 p. m	103.5	
31	9 a. m	102	
31	6 p. m	103	
Sept. 2	9 a. m	102	
2	6 p. m	103.5	Hot.
3	9 a. m	103	
3	6 p. m	104.5	Do.
4	9 a. m	102.5	
4	6 p. m	104	Do.
5	9 a. m	102	
5	6 p. m	103	Cooler.
6	9 a. m	102.3	
6	6 p. m	104	
7	9 a. m	102.5	
7	6 p. m	103.75	
8	9 a. m	102.75	
8	6 p. m	104	
9	9 a. m	102.25	
9	6 p. m	103.75	
10	9 a. m	102	
10	6 p. m	103.75	
18	6 p. m	103.75	Inoculated with one drachm peritoneal exudation slightly putrid, from a sick pig at Camden, N. J.
19	9 a. m	103	
19	6 p. m	103.75	
20	9 a. m	102.75	
20	6 p. m	104	
21	9 a. m	102	
21	6 p. m	103.75	
22	9 a. m	102	
22	6 p. m	103	

FEMALE BERKSHIRE PIG, No. 7—Continued.

Date.	Time.	Body temperature.	Remarks.
1880.		° *F.*	
Sept. 23	9 a. m	103	
23	6 p. m	104.5	
24	9 a. m	102	
24	6 p. m	102.5	Cool.
25	9 a. m	103	
25	6 p. m	103.75	Day warm. Patient dull, sluggish; anus tender, contracted.
26	9 a. m	102.5	
26	6 p. m	102.75	
27	9 a. m	101	
27	6 p. m	102	
28	9 a. m	102	
28	6 p. m	103.5	
29	9 a. m	102	
29	6 p. m	102.5	
30	9 a. m	102	
30	6 p. m	103.75	
Oct. 1	9 a. m	102	
1	6 p. m	103.5	
2	9 a. m	102.75	Thirsty; feeds sparingly.
2	6 p. m	104	
3	9 a. m	103	
3	6 p. m	105.5	
4	9 a. m	102.5	
4	6 p. m	103	
5	9 a. m	102	
5	6 p. m	103	
6	9 a. m	102.5	
6	6 p. m	104.5	
7	9 a. m	102	
7	6 p. m	103	
8	9 a. m	103	Dull; careless of food.
8	6 p. m	105	
9	9 a. m	103	
9	6 p. m	104	Abscess in seat of inoculation open.
10	9 a. m	103	
10	6 p. m	104	Warm.
11	9 a. m	103	
11	6 p. m	104.5	
12	9 a. m	103.5	
12	6 p. m	103	
13	9 a. m	103	
13	6 p. m	104	Purges.
14	9 a. m	103	
14	6 p. m	104.5	
15	9 a. m	104.5	Dull, purges.
15	6 p. m	104.75	
16	9 a. m	104	Do.
16	6 p. m	105	
17	9 a. m	102	Do.
17	6 p. m	102.5	
18	9 a. m	101	Do.
18	6 p. m	102	
19	9 a. m	99	Do. Very low.
19	6 p. m	98	Very low.
20	9 a. m	98	Dull, purges.
20	6. p m	96	
21			Found dead this morning.

POST-MORTEM EXAMINATION, OCTOBER 21, 2 P. M.

Skin, snout, ears, throat, abdomen, inside of fore and hind legs and of thighs dark red or mottled, the discoloration extending through the whole thickness of the skin in such parts. There is engorgement, capillary stasis, and rupture. Subcutaneous fat is fairly abundant.

In the right flank are two abscesses with inspissated and almost caseous contents, marking the seats of inoculation.

The *external inguinal* and *guttural lymphatic glands* are enlarged and congested of a dark red.

On the right border of the *tongue*, at the base and near the middle, are two ulcers, each having a central yellow slough, and measuring about 3 lines by 2. Around the margin of each ulcer the tissues are of a dark red, almost black.

Lungs, sound.

Heart, right side, contains dark fluid blood.

Left side and *large arteries* inclose a clot of fibrine almost devoid of red globules.

The *left kidney* has a large cyst on its convex aspect filled with a limpid yellowish urine. This caused such an indentation that it gave the appearance of a hilus on the outer border as well as on the inner. The pelvis was also fully distended with urine, but no obstructing calculus was found. The organ showed some dark red plaques on its surface. The *right kidney* was large, but apparently healthy. The bladder was filled with a limpid yellowish urine.

The *liver* was a very dark purple and unnaturally friable; the bile dark green, thick, and tenacious.

The *stomach* had the mucous membrane covering the great curvature of a brownish red, with small black clots of extravasated blood on the summits of the mucous folds and even elsewhere, so that the surface had a maculated aspect.

The *small intestines* show patches of congestion at intervals.

The *cæcum* and *colon* have their mucous membrane congested, so that the cut surface appears dark and bloody like the black portions of the skin. No ulcers are found.

The *mesenteric lymphatic glands* are of a dark red, especially those belonging to the small intestines.

REMARKS.

In this case the inoculation in urine produced a certain amount of fibrile reaction, but this did not protect the system from the deadly effects of a hypodermic injection of a drachm of the slightly overkept virulent peritoneal exudation obtained from New Jersey. This case unfortunately was not subjected to simple exposure to infection to ascertain whether the inoculated urine would prove protective against that mainly because on the 18th September I was not sufficiently alive to the dangers of a great overdose of poison administered hypodermically.

FEMALE BERKSHIRE PIG, No. 8.

Date.	Time.	Body temperature.	Remarks.
1880.		° F.	
July 27	6 p. m	105.25	The high temperature caused by a chase.
28	9 a. m	102.75	
28	6 p. m	103	
29	9 a. m	102.5	Inoculated with infected milk that had been two days in incubator and accidently exposed to 120° F., or even more.
29	6 p. m	103.25	
30	9 a. m	102.5	
30	6 p. m	104	
31	9 a. m	103	
31	6 p. m	104	
Aug. 1	9 a. m	103	
1	6 p. m	105	
2	9 a. m	102.5	
2	6 p. m	103.5	Cold.
3	9 a. m	101.75	Cold and wet.
3	6 p. m	103	Do.
4	9 a. m	102	Do.
4	6 p. m	101.5	Do.
5	9 a. m	101.75	
5	6 p. m	101.5	
6	9 a. m	101.75	Inoculated with milk infected July 29.
6	6 p. m	102.75	
7	9 a. m	101.5	
7	6 p. m	102.5	
8	9 a. m	101.75	
8	6 p. m	104.75	
9	9 a. m	103	
9	6 p. m	104.25	
10	9 a. m	102	
10	6 p. m	104.25	
11	9 a. m	101.5	
11	6 p. m	103	
12	9 a. m	102	
12	6 p. m	103	
13	9 a. m	101.5	Inoculated with pus from inoculation swelling of No. 2. See microscopic drawings, Fig. 4.
13	6 p. m	103	
14	9 a. m	103	
14	6 p. m	101	

FEMALE BERKSHIRE PIG, No. 8—Continued.

Date.	Time.	Body temperature.	Remarks.
1880.		° F.	
Aug. 15	9 a. m	100	Cold, showery.
15	6 p. m	102	
16	9 a. m	99.7	
16	6 p. m	102.5	
17	9 a. m	100	Cold.
17	6 p. m	102.75	
18	9 a. m	101	Cold, threatening. A nodule like a bean where last inoculated.
18	6 p. m	102.5	
19	9 a. m	101	Warm, wet.
19	6 p. m	103.5	
20	9 a. m	102	Do.
20	6 p. m	101.5	
21	9 a. m	101.5	Muggy.
21	6 p. m	102	
22	9 a. m	102.75	
22	6 p. m	103.75	
23	9 a. m	102.5	
23	6 p. m	103.75	Hot.
24	9 a. m	101.75	
24	6 p. m	104.5	Do.
25	9 a. m	101	
25	6 p. m	102.25	
26	9 a. m	101	
26	6 p. m	102	
27	9 a. m	102	
27	6 p. m	104	
28	9 a. m	101.75	
28	6 p. m	103.75	
29	9 a. m	101.5	
29	6 p. m	103.5	
30	9 a. m	101.5	Cold, wet.
30	6 p. m	103	
31	9 a. m	101	
31	6 p. m	102	
Sept. 2	9 a. m	101	
2	6 p. m	103	
3	9 a. m	102	Inoculated with infusion of bran inoculated with virus from North Carolina and cultivated three days.
3	6 p. m	103.25	Hot.
4	9 a. m	102	
4	6 p. m	103.5	
5	9 a. m	101.5	
5	6 p. m	102.5	
6	9 a. m	101.5	
6	6 p. m	102	
7	9 a. m	102.75	
7	6 p. m	102.5	
8	9 a. m	101.75	
8	6 p. m	102.5	
9	9 a. m	102	
9	6 p. m	103	
10	9 a. m	102	
10	6 p. m	102.75	Has been sick during the past week.
18	6 p. m	103	Inoculated by injecting hypodermically one dram of virulent peritoneal exudation slightly septic, from sick pig, in New Jersey.
19	9 a. m	102.5	
19	6 p. m	103	
20	9 a. m	102	
20	6 p. m	103	
21	9 a. m	101.75	
21	6 p. m	102.75	
22	9 a. m	101.5	A diffuse swelling in the seat of inoculation.
22	6 p. m	102.5	
23	9 a. m	101	
23	6 p. m	102	Snuffles in breathing.
24	9 a. m	101	Snuffling breathing continued more or less to the end.
24	6 p. m	103	
25	9 a. m	102	
25	6 p. m	102.25	Skin scurfy and unhealthy, but bright, and has a good appetite.
26	9 a. m	101	
26	6 p. m	102	
27	9 a. m	101.5	
27	6 p. m	102	

FEMALE BERKSHIRE PIG, No. 8.—Continued.

Date.	Time.	Body temperature.	Remarks.
1880.		° F.	
Sept. 28	9 a. m.	101	
28	6 p. m.	102	
29	9 a. m.	100	
29	6 p. m.	101	
30	9 a. m.	101	
30	6 p. m.	102. 75	
Oct. 1	9 a. m.	101	
1	6 p. m.	102. 5	
2	9 a. m.	101. 25	
2	6 p. m.	102. 75	
3	9 a. m.	101	
3	6 p. m.	102. 5	
4	9 a. m.	101	
4	6 p. m.	102. 5	
5	9 a. m.	100	
5	6 p. m.	101	
6	9 a. m.	100	
6	6 p. m.	101. 5	
7	9 a. m.	100. 75	
7	6 p. m.	102. 5	
8	9 a. m.	101	
8	6 p. m.	102	
9	9 a. m.	101	
9	6 p. m.	102	
10	9 a. m.	101	
10	6 p. m.	102. 5	
11	9 a. m.	101	
11	6 p. m.	101. 5	
12	9 a. m.	100	
12	6 p. m.	101. 5	
13	9 a. m.	101	
13	6 p. m.	102. 5	
14	9 a. m.	100	
14	6 p. m.	101. 75	
15	9 a. m.	102	
15	6 p. m.	102. 5	
16	9 a. m.	102. 5	
16	6 p. m.	104	
17	9 a. m.	100	
17	6 p. m.	100	
18	9 a. m.	99. 5	
18	6 p. m.	100	
19	9 a. m.	98	
19	6 p. m.	98	Has to be lifted to drink from this time onward.
20	9 a. m.	99	
20	6 p. m.	102	
21	9 a. m.	100	
21	6 p. m.	102	
22	9 a. m.	101	Purges and is very weak.
22	6 p. m.	102. 5	Purging constant from this time.
23	9 a. m.	101	
23	6 p. m.	102. 75	
24	9 a. m.	104	
24	6 p. m.	104	
25	9 a. m.	103. 25	
25	6 p. m.	103. 5	
26	9 a. m.	103. 25	
26	6 p. m.	103. 5	
27	9 a. m.	101. 5	
27	6 p. m.	101. 75	
28	9 a. m.	101. 5	
28	6 p. m.	102. 5	
29	9 a. m.	102. 75	
29	6 p. m.	103. 75	
30	9 a. m.	102. 5	
30	6 p. m.	104. 5	
31	9 a. m.	104	
31	6 p. m.	104. 5	
Nov. 1	9 a. m.	104	
1	6 p. m.	104. 25	
2	9 a. m.	103	
2	6 p. m.	104	
3	9 a. m.	103. 5	
3	6 p. m.	104	
4	9 a. m.	104	
4	6 p. m.	104. 5	
5	9 a. m.	104	
5	6 p. m.	104	
6	9 a. m.	103	
6	6 p. m.	103	

FEMALE BERKSHIRE PIG, NO. 8.—Continued.

Date.	Time.	Body temperature.	Remarks.
1880.		° F.	
Nov. 7	9 a. m	103	
7	6 p. m	103	
8	9 a. m	102.5	
8	6 p. m	102.25	
9	9 a. m	102	
9	6 p. m	102	
10	9 a. m	101.5	
10	6 p. m	101	
11	9 a. m	92	The body is very much emaciated, the hind legs cold and rigid, and blue from the thighs downward. Snout blue. A frothy discharge flows from the nostrils.

The pig was now killed by bleeding. Very little blood flowed, but this was quite red, clotted firmly without buffy coat, and was long in showing signs of active putrefaction.

POST-MORTEM EXAMINATION.

A wound made six days ago on the back of the ear, to obtain a drop of blood, is still open and suppurating.

The *tongue* has a yellow fur on the dorsum. The *right tonsil* has enlarged follicles, with yellowish, cheesy, granular contents.

The *guttural lymphatic glands* enlarged and pigmented, of a dark gray color. The *prepectoral* and *subdorsal glands* are in the same condition.

The *lungs* are of a pale pink, with spots of blood-red extravasation, probably from the inhalation of blood in dying.

The *heart* is soft, flaccid, and pale, as if parboiled, and empty.

The *inguinal sublumbar* and *iliac lymphatic glands* are enlarged and pigmented. The *rectal lymphatic glands* are black.

The *mesenteric, gastric,* and *hepatic lymphatic glands* are of a dark gray, with patches of deep red.

The *bowels* show patches of congestion, but no abrasion nor ulcer is found.

The *kidneys* have their cortical part of a yellowish brown and friable, the medullary portion, and especially the papillæ, of a deep red.

The *liver* is of a deep red color with darker purple patches. It is gorged with blood and bleeds freely on section. The *bile* in the gall bladder is small in quantity and inspissated to the consistency of a tenacious semi-solid dark green mass.

Brain and *spinal cord:* Subarachnoid fluid in excess. The coverings of the brain are deeply congested, and the puncta vasculosa very numerous and large. The whole of the gray matter seems to have a slightly pink tinge.

The *internal* and *middle ear* on the left side is the seat of a deposit of a dark gray cheesy matter, the surface of the bone is in great part denuded of periostium, and ulceration has progressed to a considerable extent.

REMARKS.

The two first inoculations of this pig with the cultivation of the virus in the milk produced a very slight constitutional reaction. The subject appeared to resist an inoculation with a minimum amount of virus from No. 2, yet, like all its predecessors, it sickened under the influence of a large hypodermic injection of the virus as cultivated in bran, and succumbed to the hypodermic injection of a drachm of the peritoneal exudation from a sick pig in New Jersey. This test, as I have now learned, is far too severe, and out of all proportion to a simple exposure in an infected place, or cohabitation with diseased animals, yet the recent lesions in the skin, lymphatic glands, lungs, and bowels were so inconsiderable that it is not at all improbable this animal would have survived but for the accidental implication of the internal ear and the brain. These last accounted for the persistent snuffling breathing, the increasing lethargy, and paralysis, and the utter inability to rally.

WHITE PIG, No. 9.

Date.	Time.	Body temperature.	Remarks.
		° F.	
1880. Aug. 23	6 p. m	104. 5	Placed in infected pen with No. 2, and inoculated from dried virus on quill from North Carolina.
24	9 a. m	103	
24	6 p. m	104	
25	9 a. m	102	Scours.
25	6 p. m	103	Do.
26	9 a. m	101. 5	Do.
26	6 p. m	102. 75	Do.
27	9 a. m	102	Do.
27	6 p. m	104	Do.
28	9 a. m	101. 5	Do.
28	6 p. m	103	Do.
29	9 a. m	101	Do.
29	6 p. m	103. 75	Do.
30	9 a. m	102	Do.
30	6 p. m	103. 75	Scours; placed in infected pen with No. 6.
31	9 a. m	102	
31	6 p. m	104	
Sept. 1	9 a. m	102	
1	6 p. m	103. 5	
2	9 a. m	102. 5	Inoculated by hypodermic injection of 1 drachm virulent liquid cultivated in wheat bran for three days.
2	6 p. m	105	
3	9 a. m	103	Swelling one-half inch in diameter where inoculated.
3	6 p. m	104. 75	
4	9 a. m	102. 5	
4	6 p. m	103. 75	
5	9 a. m	102	
5	6 p. m	103. 5	
6	9 a. m	102	
6	6 p. m	103. 5	
7	9 a. m	102. 5	
7	6 p. m	103. 5	
8	9 a. m	102. 25	
8	6 p. m	103. 75	
9	9 a. m	102. 5	
9	6 p. m	104	
10	9 a. m	102. 25	
10	6 p. m	103. 75	
18	6 p. m	103. 5	
19	9 a. m	102	
19	6 p. m	104	
20	9 a. m	102	
20	6 p. m	103. 5	
21	9 a. m	101. 75	
21	6 p. m	103. 25	
22	9 a. m	101. 5	
22	6 p. m	102. 5	
23	9 a. m	101. 5	
23	6 p. m	102. 5	Tail and ears livid.
24	9 a. m	102. 5	
24	6 p. m	103	
25	9 a. m	103. 5	Day warm. Scours and is very dull.
25	6 p. m	103. 2	Scours and is very dull.
26	9 a. m	103. 5	Do.
26	6 p. m	104. 75	Do.
27	9 a. m	104	Do.
27	6 p. m	104. 75	
28	9 a. m	104	
28	6 p. m	104. 5	Do.
29	9 a. m	103. 75	Do.
29	6 p. m	105. 5	Do.
30	9 a. m	103	Do.
30	6 p. m	103. 75	Do.
Oct. 1	9 a. m	103	Do.
1	6 p. m	104	Do.
2	9 a. m	103. 5	Do.
2	6 p. m	105. 5	Do.
3	9 a. m	104	Do.
3	6 p. m	107	Do.
4	9 a. m	104. 5	Scours. Fœtid part of tail separating.
4	6 p. m	107. 5	Scours. Ears blue throughout.
5	9 a. m	104	Scours.
5	6 p. m	106	Scours. Inguinal glands enlarged.
6	9 a. m	104.5	Scours.
6	6 p. m	107	Do.

WHITE PIG, No. 9—Continued.

Date.	Time.	Body temperature.	Remarks.
1880.		° *F*	
Oct. 7	9 a. m.	103	Scours.
7	6 p. m.	104.5	Do.
8	9 a. m.	102	Scours. Weak; staggers; trembles.
8	6 p. m.	102.5	Do.
9			Died to-day. Necropsy at once.

POST-MORTEM OBSERVATIONS, 4 P. M.

Body still warm. *Rigor mortis* setting in.

Skin: Snout has its upper third very dark red, lower two-thirds black. *Lower jaw* and intermaxillary space of a dark red. *Ears* of a dark bluish red, except at the base of the concha, where it is spotted, the dark red spots being unchanged by pressure. The *right eye* has a sore on the lower lid at the inner angle, two lines in length by one in breadth, presenting a dark scab or slough with white scaly margins and a dark red or livid areola. A smaller slough exists in the middle of the upper lid with white scaly crust. Apart from the sores the lids are pale, but the surrounding skin is of a dark bluish red. Both lids and conjunctiva of the left eye are of a deep bluish red, with a slough about a line in length on the mucous membrane inside the middle of the upper lid. The breast, sheath, and adjacent parts of the abdomen, the perineum, rump, tail, and insides of the fore and hind limbs are of a deep bluish red. Half of the tail is in a sloughing condition. No swelling remains in the seat of inoculation.

The *guttural* and *parotid lymphatic glands* are two or three times their natural size, and of a very deep red color.

The *tongue* has on its right margin three yellow ulcers, each from one line to one and a half lines, and becoming confluent. Another smaller ulcer is opposite the circumvallate papillæ.

The *prepectoral glands* are enlarged and of a very dark red.

The *bronchial lymphatic glands* are of a deep red, but not so dark.

The *right heart* and large veins contain large clots of a very dark color.

The *left heart* holds a smaller clot, also very dark.

Lungs: A wedge-shaped mass in the posterior portion of the *right lung* is hepatized and almost black, the hepatization being circumscribed by the lobulettes. The whole posterior portion of the *left lung* is solid from hepatization and almost black. The lower portion of the entire lung is of a deep dark red, and mostly carnified. (See Plate IV.)

The *superficial inguinal glands* are greatly enlarged and of a dark red.

A small abscess with fœtid puriform contents exists beneath the peritoneum on the right side near the seat of inoculation.

The *liver* is dark bluish red and friable. The *gall bladder* is full, but not over-distended, with dark green, thick, tenacious bile.

The *spleen* is blue mottled, normal in size and consistency.

Lower surface of both kidneys thickly studded with black petechiæ about the size of pins' heads. (See Plate V, Fig. 1.) On section the cortical substance appears of a yellowish brown, the medullary of a pink hue.

The sublumbar, emulgent, and rectal lymphatic glands are of a dark red hue; the mesenteric glands mottled, red, and dirty white.

The *stomach* has the mucous membrane of its greater curvature of a deep dark red, excepting on the summits of the rugæ, which are pale or pinkish yellow, according to the congestion. There are several sores with yellowish sloughs near the margin of the congested area. Also an extensive yellow fur like a diphtheritic membrane somewhat nearer to the pylorus. (See illustration, Plate V, Fig. 2.)

The *gastric lymphatic glands* are of a very deep red and considerably enlarged.

Both *small* and *large intestines* are congested at intervals. The *rectum* is congested, of a very deep red. The mucous membrane is softened and presents several spots, each from one to two lines in diameter, evidently due to extravasation of blood. (See Plate VI.) Peyer's patches on the ilio-cæcal valve has its follicles greatly enlarged and filled with a yellowish cheesy material. (See Plate VII, Fig. 1.)

SMALL WHITE PIG, NO. 10.

Date.	Time.	Body temperature.	Remarks.
		° F.	
1880. Aug. 23	6 p. m	104.5	Inoculated with virus from North Carolina dried on a quill. Placed in infected pen with No. 2.
24	9 a. m	103	
24	6 p. m	104	
25	9 a. m	102	Scours.
25	6 p. m	103.5	Do.
26	9 a. m	101.5	Do.
26	6 p. m	103	Do.
27	9 a. m	102	Do.
27	6 p. m	104	Do.
28	9 a. m	102.75	Do.
28	6 p. m	104	Hot.
29	9 a. m	102	Hot.
29	6 p. m	103	Cool.
30	9 a. m	102	Cold, wet.
30	6 p. m	104	
31	9 a. m	102	
31	6 p. m	104	
Sept. 2	9 a. m	102.5	
2	6 p. m	103.75	
3	9 a. m	103	Inoculated by hypodermic injection of one-half drachm infusion of bran, infected three days before.
3	6 p. m	105	
4	9 a. m	103	
4	6 p. m	104	
5	9 a. m	102.5	
5	6 p. m	104	
6	9 a. m	102.5	
6	6 p. m	103.75	
7	9 a. m	102.75	
7	6 p. m	104	
8	9 a. m	103	
8	6 p. m	104.25	
9	9 a. m	103	
9	6 p. m	104	
10	9 a. m	102.25	
10	6 p. m	103.75	
18	6 p. m	104	Has been improving and looks hopeful. Inoculated with one-half drachm of virulent peritoneal exudation partly septic.
19	9 a. m	102	
19	6 p. m	103.5	
20	9 a. m	102	
20	6 p. m	103.75	Costive.
21	9 a. m	102	
21	6 p. m	103	
22	9 a. m	102	
22	6 p. m	103.5	
23	9 a. m	103	
23	6 p. m	104.75	Costive. Fæces have a mucous coating.
24	9 a. m	103	
24	6 p. m	104	Costive. Trembles at times.
25	9 a. m	103	Bowels easy without purging. Ears livid.
25	6 p. m	104.75	
26	9 a. m	103.5	
26	6 p. m	106	
27	9 a. m	103.5	
27	6 p. m	104.75	
28	9 a. m	104.5	
28	6 p. m	105.5	
29	9 a. m	104.5	
29	6 p. m	106	
30	9 a. m	104	
30	6 p. m	105.75	
Oct. 1	9 a. m	104	
1	6 p. m	105.75	
2	9 a. m	104.5	
2	6 p. m	106	
3	9 a. m	105	
3	6 p. m	108.25	
4	9 a. m	105	
4	6 p. m	106.5	Purges; very dull. Purple skin on ears, breast, abdomen, and legs.
5	9 a. m	104	
5	6 p. m	105	
6	9 a. m	104	
6	6 p. m	105.25	
7	9 a. m	103	
7	6 p. m	104.5	
8	9 a. m	103	Inguinal glands very large.

SMALL WHITE PIG, No. 10—Continued.

Date.	Time.	Body temperature.	Remarks.
1880.		° F.	
Oct. 8	6 p. m.	103.5	Very dull, weak. Tail and ears dark blue and cold.
9	9 a. m.	102	
9	6 p. m	102.75	
10	9 a. m.	101	
10	6 p. m	102.75	
11	9 a. m	100	
12			Found dead. Necropsy the same forenoon.

LESIONS OBSERVED AFTER DEATH.

Skin is generally of a dark bluish red, the color being especially deep on the upper jaw, snout, lower jaw, intermaxillary space, throat, breast, abdomen, eyelids, ears, inner sides of the fore and hind limbs, the outer side of the shoulder, and the perineum. Where the color is lightest (of a dark crimson) it can be partially whitened by pressure; but the white surface remains sprinkled with red spots, and the whole crimsons again instantly on the removal of the pressure.

The *superficial inguinal glands* are enormously enlarged and of a deep red, and at points almost black. The *submaxillary* and *guttural lymphatic glands* are in the same condition; the *prepectoral* are not so much enlarged, but of an intensely dark red.

The margin of the anterior half of the *tongue* has eleven sores with yellow sloughs averaging about a line in diameter, and each surrounded by a dark bluish red areola. A still larger ulcer of the same kind exists on the lower surface of the tongue in front of the frenum. (See illustration, Plate VII, Fig. 2.)

Several of the follicles of the *tonsils* are overdistended with a yellow granular material which can be squeezed out in a vermiform mass.

The *left lung* has nearly the whole anterior lobe hepatized with friable whitish-yellow false membrane on the surface binding it loosely to the pericardium and costal pleura. The lower border of the middle lobe is also covered with false membrane, and is slightly adherent to the ribs; but the lung itself is only to a very slight extent involved.

The *right lung* has a few lobules in each of the anterior and middle lobes hepatized. One hepatized lobule near the posterior margin of the posterior lobe stands out dark, red, and firm; but the lesion is sharply circumscribed by the margin of the lobule in question, and those adjacent to it are quite natural.

The *heart* is normal. A large clot in the right ventricle is slightly buffed.

The *liver* is of a dark purple, and firm in texture. The *bile* of a rich orange color and glutinous.

The *spleen* is apparently normal; there is neither engorgement nor shrinking.

Abdomen.—The *colon* is adherent to the parietal peritoneum at two points near the umbilicus, and at such points there are circumscribed abscesses in the walls of the colon.

The *stomach* has the mucous membrane of its great curvature of a very dark red, at points almost black. The rugæ are very prominent. Near the left *cul de sac* is a circular projecting sloughing ulcer, about 1½ lines in diameter with a dark center, yellow margin, and very dark red areola. This has the general character of the ulcers usually found in the cæcum and colon in this disease. Close to the cardiac are two more similar ulcers with depressed center, encircled by a raised yellow ring of sloughing material, and around this another dark red ring gradually shading off into the hue of the adjacent mucous membrane. The last two ulcers are on the margin of a patch 1 inch long by ½ inch broad, covered by a thick bright yellow concretion. (See Plate VIII.)

The *duodenum* is conjested, with dark red petechial patches at intervals. Limited portions of the small intestines have the mucous membrane thickened, softened, and of a deep red, and considerable blood has been effused into the lumen of the gut.

The *ileo cæcal* valve has a few of its glandular follicles distended with a firm yellowish material.

The *cæcum* has one prominent circular sloughing ulcer with dirty yellow center and dark margin; also several black petechial plaques, some of which are already abraded on the surface, and commencing to ulcerate. (See Plate IX.)

The *colon* presents similar ulcers, also plaques of extravasation, and small abscesses under the peritoneal coat, where it was found adherent to the lower wall of the abdomen.

The *rectum* is congested and mottled with dark spots of extravasation and, at one point on the peritoneal surface of the bowel, a thick yellow mass like altered blood.

The *sublumbar*, *mesenteric* and *gastric glands* are enlarged and congested of a very deep red.

Table showing dates of inoculations and final results.

Number.	Date when received.	Infected by exposure.	INOCULATED.								Died.	
			With fresh virus.	With virus preserved in vacuum tubes.	With virus cultivated in milk.	With virus cultivated in urine.	With virus cultivated in egg albumen.	With virus cultivated in dry bran.	With virus dried on quill.	With liquid exudate slightly putrid.		
1	June 9	1 came sick	June 23	July 10							July 17	Never fully recovered from first attack.
2	do	do	do	do				Sept. 2		Sept. 18	Nov. 24	Died of constipation and encephalitis.
3	June 26	do			July 3						July 15	Never fully recovered from first attack.
4	June 27			July 10			July 3	Sept. 3	Aug. 13	Sept 18	Sept. 29	
5	do	August 10, put in infected pen.		do		July 3		do	do	do	Oct. 2	
6	July 10	August 12, put in infected pen.		do	Aug. 6			do		do	Oct. 19	
7	July 27				July 29	Aug. 6				do	Oct. 21	
8	do		August 13, pus from inoculation swelling.		Aug. 6			Sept. 3		do	Nov. 10	
9	Aug. 23	August 23, put in infected pen.						do	Aug. 23		Oct. 9	
10	do	do						do	do	Sept. 18	Oct. 12	

Table showing the results of inoculations of variable quantities of primary and cultivated virus.

	Number inoculated with 1 drop.	Protected.	Unprotected.	Number inoculated with ½ to 1 drachm.	Protected.	Unprotected.	Died.	Survived.
PRIMARY VIRUS.								
Fresh virus	1	1						1
Virus eight days in sealed tube				5	4	1	4	1
Virus dried on quill	3	2	1				1	2
Virus slightly septic				5	5		5	
CULTIVATED VIRUS.								
In milk				3	2	1	1	2
In albumen				1		1		1
In urine				2	2			2
In bran				*6	*6			
	4	3	1	22	19	3	11 or 16	9

* All very sick, perhaps fatally.

SUMMARY OF RESULTS.

As yet my experiments have been conducted on a limited number of subjects, and therefore cannot be advanced as absolutely conclusive, yet they furnish hopeful indications that by pursuing certain lines of experiments still further we may arrive at a satisfactory means of prevention. So far I have been largely feeling my way so as to discover the channels that promise success, and those that are to be at once discarded as not only useless but dangerous. The avoidance of paths that are known to be perilous serve but to more and more narrow our sphere of acting to those that give the brightest promises. In the following summary I have therefore noted what methods have proved constantly and hopelessly bad, as well as those that have given good promise of success.

1st. *The inoculation of a pig with an excess in quantity of disease-germs is always highly dangerous and often fatal in its results.*—In *ten* successive experiments fatal results followed the inoculation by injection under the skin of one drachm of the virulent fluid. While in the tenth case the death was deferred more than two months and the lesions (constipation and phrenitis) were not such as to warrant the conclusion that the patient died of swine plague, yet the victim drooped after the two last excessive inoculations as he had never done before, and the system was so reduced that he became an easy prey to the last fatal illness.

2d. *Inoculation with a minimum quantity of virus produces relatively less dangerous results.*—In *five* subjects inoculated with a drop or less of fresh virus, all except one survived long enough to show that death was in no way due to that inoculation. The *fifth* and *fatal case* was inoculated eleven days later with a maximum quantity of virus cultivated in wheat-bran, and it is doubtless to this that its death, thirty-six days later, was due.

3d. *Exposure to infection is comparable to inoculation with a minimum amount of virus.*—This is practically shown in the results of exposing the experimental pigs in infected pens, and cohabitation with the sick.

Three subjects thus exposed after they had been protected by a previous inoculation bore the ordeal successfully, and only sickened seriously months later when they had been subjected to the hypodermic injection of a maximum amount of the virulent fluid. Two others that had been placed in infected pens before they had been subjected to any protective inoculation survived such exposure, respectively, for forty-seven and fifty days; and each had been inoculated with a maximum amount of virus, thirty-six and thirty-nine days respectively before death, and finally one had been reinoculated with a maximum quantity twenty-four days before death. The record shows that these two died of the later inoculations and not of the exposure in infected pens. In estimating the worth of the results obtained, therefore, we must not judge in any case by the impotence of any one method to protect against the injection of a maximum dose of very virulent material, but rather by its power to ward off evil results when the subject is simply exposed in an infected building or inoculated with a minimum quantity of virus. The fatal results of the excessive doses served one good result in giving the assurance that it was virulent and not non-virulent matter that was being used.

4th. *Reinoculation with fresh virus during the progress of the disease in a patient does not mitigate the illness nor protect against a further attack, but rather insures and hastens a fatal issue.*—Seven cases (Nos. 1, 3, 4, 5, 6, 8, and 10) show this very distinctly. The conclusion might have been arrived at *a priori* from the fact that such second inoculation was but an addition made to the disease germs which were sapping the springs of life. On the other hand there was the doctrine maintained by Neucki, Bauman, and Wernich that the bacteria are destroyed by the products of the putrefaction they cause, and that the immunity acquired after a first attack is probably due to the presence of such products in the system. Were this the case the greater the numbers of the bacteria and of their products, the earlier should be the recovery. But the undoubted fact that an excessive dose of the poison will overcome the acquired protective influence, and the no less certain fact that the further introduction of diseased germs into the body of a sick subject aggravates the illness, tend to invalidate the position, and to send us elsewhere for a rational explanation of the immunity. The first practical deduction from the result is, that in seeking immunity or protection by subjecting an animal to a mild or mitigated attack of the disease, we must carefully seclude it from all exposure to infection until recovery from the first attack is complete.

5th. *Virulent matter which has been packed firmly in dry wheat bran has its potency increased.*—This I had found to be the case when experimenting on this subject in 1878, and I now made a similar cultivation of the virus to serve as a crucial test of the degree of immunity acquired by an animal in passing through the disease, as contracted in the usual way, and as produced by inoculations with modified virus. Experiment showed, however, that inoculation with a maximum quantity of the bran culture was dangerous in all cases, and that even immunity which resisted an ordinary exposure was comparatively powerless against this. Of seven pigs inoculated with the bran cultivation six were severely ill, one died, and the others were reinoculated with a virulent peritoneal exudate slightly putrid, before they had fully recovered. It is noticeable that this culture in bran, like the preservation of the virus in a corked bottle to be noticed next, determined a growth with a limited supply of air, and the question may well arise whether it is not this culture of the virus without a free access of air which enhances its

potency. The solution of this question would have a direct bearing upon the preservation of the poison in infected buildings under tight floors, in wood work, in manure, litter, straw stacks, fodder, &c.

6th. *Partial putrefaction growth of the virulent products in a limited amount of air increases their potency.*—This seemed to occur in a bottle of virulent matter sent me from Illinois in 1878 (see No. 5 of my report for 1879), and now it is fully confirmed by the results of inoculations with peritoneal exudate, and diseased lungs sent me in bottles from New Jersey, and slightly putrid on arrival.

Of seven pigs inoculated with a drachm of this fluid all perished except one (No. 2), which fell off in health and died later of constipation and phrenitis. Experiments conducted in 1878 seemed to show that putrefaction in free air finally destroyed the virus of swine plague, as it is known to do that of malignant anthrax; but in view of the excessive virulence of the liquid that has become slightly putrid with a limited supply of air, it may well be questioned whether swine plague may not be but a modified form of septic infection. I have in progress some experiments which may throw more light on this subject. One pig inoculated with infusion of pork filled with bacteria from inoculation with an infusion of maize was afterward inoculated with fresh virus and placed in an infected pen. He had a sharp attack, but now seems in a fair way to recover. Other experiments on the same subject are in progress.

7th. *Inoculation with a culture of the virus in egg albumen seemed to protect against the effects of a subsequent inoculation with fresh peritoneal exudate, and with virus dried on a quill.*—Subsequent inoculations with a maximum quantity of a culture in wheat bran, and of slightly putrid peritoneal exudate, proved fatal.

8th. *Inoculation with a culture of the virus in human urine protected against the effects of subsequent inoculations with virus that had been preserved in a vacuum tube, and with virus dried on a quill.*—Subsequent inoculations with the culture of the virus in bran, and with the putrid peritoneal exudate, in maximum quantity, proved fatal in both cases.

9th. *Inoculation with the virus cultivated in cow's milk produced a mild attack and an immunity against the effects of exposure in an infected pen, and of inoculation from an infected wound, and secured a mild attack of the inoculation with cultivation in wheat bran.*—Subsequent inoculations with the slightly putrid peritoneal exudate proved fatal in these as in other cases.

EXPERIMENTS NOW IN PROGRESS.

Three pigs are now under experiment to ascertain the protective effect of introducing into the system the products of the fermentation caused by bacteria, while the live bacteria are themselves excluded. *One* was subjected to the products formed in an infusion of pork which had swarmed with bacteria developed from an inoculation with the liquid of decomposing Indian corn. The bacteria was destroyed by heat and the non-vital liquid only was used. Exposed to infection and inoculated, this pig has had a smart attack of illness, but at present seems in a fair way to recover. A *second* was treated with the blood of a sick pig after it had been similarly heated to destroy any existing bacteria, and this was once repeated after the effects of the first inoculation had passed off. A *third* was similarly subjected to devitalized solution of the dung of a sick pig, on one occasion only. These last were in due time placed in an infected pen in company with a sick pig, but so far they have shown no sign of illness.

Should experiments in this line furnish an available method of pro-

tection, it must supersede all other modes in which the living disease germs, in however mitigated a form, is introduced into the system. The living germ is always liable to increase from small beginnings to infinite quantities. It is further liable in favorable states of the system to part with its milder characteristics and resume the more virulent and deadly. But if the products of the bacteridian fermentation already elaborated in another system, or in an organic liquid, will so affect the system that it shall become intolerant of the existence and growth of the bacteria within it, we are at once furnished with a mode of prevention which is likely to be as safe in its application as it may be efficient in its results. Toussaint claims that he has in this manner rendered a number of animals insusceptible to the contagion of anthrax, and if hog cholera is, like anthrax, a truly bacteridian disease, there is every reason to hope that it, too, may be prevented in this way. My first subject treated with the products of septic bacteria has not shown an absolute insusceptibility to the infection of hog cholera, yet even she appears likely to make a good recovery. The two thus treated with the products of the bacteria of swine plague have so far appeared to escape all the perils of infection.

Another line of experiment has been adopted to ascertain what relation the propagation of virulent bacteria in the circulating blood which has been deprived of most of its oxygen bears to the generation of swine plague. In my experiments the most fatal type of the poison was that which had undergone a slight putrefactive fermentation in a limited supply of air. In connection with this is the fact that in animals that die of suffocation not only have bacteria entered from the bowels into the blood of the portal vein, but they have become so virulent that a small quantity of such blood inoculated on healthy animals produced fatal results. (*Signol.*) Hogs with their naturally high temperature demand more air in proportion to their body weight than the larger domestic animals, and yet as pigs are now reared and fattened this is usually the last consideration of the owners. I hope soon to be able to show what connection there is, if any, between the deficiency of pure air for the pig and the development *de novo* of hog cholera.

Respectfully submitted.

JAMES LAW.

SUPPLEMENTAL REPORT ON SWINE PLAGUE.

Hon. WILLIAM G. LE DUC,
Commissioner of Agriculture:

SIR: In continuance of my report already sent, I now submit the following further results of my observations and the deductions to be drawn from them. The continuation of my experiments enables me to speak with greater confidence as to results, and the comparison of my own observations with those of others made on allied diseases has served to set certain views in a clearer light, and to establish principles which, I venture to hope, will form the basis of great and invaluable new departures in the field of sanitation. In view of the comparatively limited number of my own experiments on the prevailing plague of swine, I have ventured to introduce illustrative examples from other affections of man and animals, so as to show something of the breadth and solidity of the basis on which stand the principles enunciated. While at first

glance this may be thought a deviation from the immediate subject of investigation, I think no one can follow me through without seeing that this apparent digression is of the most vital importance to our study, and to the due substantiation of our results.

RESULTS OBTAINED.

The final results of my investigations may be summed up under two heads: 1st. *The virulence and fatality of the swine-plague germ is increased when grown in a very limited amount of air, and decreases as cultivated in free air.* 2d. *By placing the system of the pig under the influence of the chemical products of the growing swine-plague germ, though the germ itself is not introduced into the economy, the subject is rendered insusceptible to a future attack of the disease.*

1ST. FORCE OF THE VIRUS LESSENED BY CULTIVATION IN FREE AIR.

In my last report I had already indicated that the germ of this disease had in my hands proved much more virulent and deadly if it had been preserved for some days in a sealed bottle, or tightly packed in dry bran. Also, that the same germ as grown in different organic solutions (egg albumen, milk, urine, &c.), with free access to the air through a pledget of cotton wool, had constantly produced mild types of the affection. After my report had been sent I saw for the first time Pasteur's account of his method of mitigating the poison of *chicken cholera*, and Buchner's account of his experiments in the same direction with the poison of *malignant anthrax*. These so fully corroborated my conclusions that I felt more than ever confident in their truth, and as subsequent experiment only tended to further substantiate them, the observation appears now to be warranted that *it is a principle for diseases caused by bacteria, and not recurring a second time in the same system, that the cultivation of the germ in free air mitigates its virulence and fatality.*

To ventilate the question the results of Pasteur and Buchner are given below, together with observations on other diseases pointing to a similar conclusion, and finally my own results with the virus of swine plague.

a. PASTEUR'S METHOD WITH CHICKEN CHOLERA.

Led by his extended observations and long experience in the cultivations of mycrophytes in vinous and other fermentations, Pasteur undertook to produce a variation from the common germ of chicken cholera by cultivating it artificially in infusion of chicken flesh with long intervals of time between the successive cultures. He found that after four months and upwards the products of culture became less deadly to chickens inoculated with it. At first the inoculated chickens would survive a day or two longer, though all finally died. Then with the product of other cultivations of the germ, with still longer intervals, the inoculations did not all prove fatal; first one out of ten would recover, then two, three, four, five, and by and by nine in ten recovered. One step further and no deaths at all took place, the germs, instead of entering the blood and acting destructively there, having confined their ravages to the seat of inoculation, when they led to gangrene of a limited extent of the tissue, which in time sloughed off, leaving a healthy wound that soon healed. The system, however, was affected, and chickens that had been inoculated with this attenuated virus proved to be insusceptible to a further attack of chicken-cholera by exposure to infection.

On the other hand, the chicken-cholera virus which had been inclosed in hermetically-sealed glass tubes, containing two-thirds of the fluid and one-third of air, though set aside for six, eight, and even ten months, lost none of its virulence, and chicken infusion inoculated with the contained germs at the end of this long period became as virulent and as deadly as if it had been inoculated with the virus direct from the chicken. Pasteur logically concluded that the difference was due to the exclusion of the oxygen of the air, which slowly but surely robbed the germ of its fatal power. This was still further supported by the observation that in certain cases, in which the virulence in the cultivated virus had not been materially affected by lapse of time, the layers of the germs developed in the liquid had been so thick that the deeper strata had been to a large extent shut out from the action of the air and consequently remained unchanged.

BUCHNER'S OBSERVATIONS ON BACILLUS ANTHRACIS AND B. SUBTILIS.

It had long been noticed that the microphyte found in infusions of old hay (*Bacillus subtilis*) was practically indistinguishable from the gum of malignant anthrax (*Bacillus anthracis*) as seen under the microscope. The most appreciable distinction was that the *Bacillus subtilis* of old hay could be inoculated on the animal system without any evil result, while inoculation with the *Bacillus anthracis* produced the deadly *malignant anthrax* or *malignant pustule.* The apparent identity of the two, except in their effects, naturally roused the suspicion that the one was but a modified form of the other, though no proof was forthcoming as to the reality of the dimly-suspected transformation, nor the conditions under which it might occur. Finally Dr. Greenfield, of London, found that the cultivation of *Bacillus anthracis* for six generations in aqueous humor robbed it of its virulence and restored it to a condition in which it was indistinguishable from the *Bacillus subtilis*. The true reason of this loss of infective properties did not appear.

Buchner started in the same field, and has not only succeeded in effecting the transformation in both directions, but in demonstrating the cause of the variation. By means of an ingenious apparatus he succeeded in furnishing a fresh supply of boiled infusion of muscle to a vessel in which a culture had just been completed, and without the possibility of the introduction of germs from the atmosphere. In this apparatus he cultivated the *Bacillus anthracis* for several hundred successive generations of the germs. These cultivations, like Dr. Greenfield's, were made with free access of air, filtered from all aerial germs by passing through cotton wool. After a few generations he found that the cultivated fluid was no longer infecting when inoculated on animals. Next he found that instead of the product of cultivation being confined like a white cloud at the bottom of the liquid, a gradually-increasing amount rose to the surface. This scum was at first a thin greasy-looking layer, but this gradually thickened and became dried in successive generations, until it was found to grow readily in an acid hay infusion, and to present all the characters of *Bacillus subtilis.* Here the demonstration is most satisfactory. The virulent germ grown in free air not only loses it infecting qualities, but shows an increasing demand for oxygen by rising to the surface of the cultivation liquid, and ends by acquiring the power of growth in *acid* hay infusion in place of *alkaline* blood and animal fluids, as heretofore.

The converse transformation from the *Bacillus subtilis* of hay to the *Bacillus anthracis* was more difficult, but was finally accomplished. Buchner obtained a supply of defibrinated blood, under antiseptic precautions, inoculated with *Bacillus subtilis*, and kept it in constant motion, so that the scum on the surface should be broken up and the germs mostly beneath the surface of the liquid, a limited amount of oxygen being meanwhile conveyed to them by the constantly-moving red globules. A transitional form soon appeared, which collected in a cloud at the bottom of the liquid after the manner of *Bacillus anthracis*, but the transformation proceeded no further, and the product never became infecting. Nothing discouraged by the failure, and attributing it to the absence of spores, which could not be induced to appear in the blood, Buchner substituted for the latter the extract of meat, with which he was entirely successful. In this the spores formed, virulence was acquired, rabbits and mice were successfully inoculated, and their blood in its turn produced *malignant anthrax* in the animals inoculated with it.

Here we not only find Pasteur's observations confirmed in principle, but that principle carried a step further. The influence of an excess of air or oxygen on the successive generations of the *virulent germ* robs it of its infecting qualities, but on the other hand the growth of the *non-virulent germ* for a series of generations with a very restricted supply of air finally endows it with properties the most deadly.

PRESERVATION OF THE ANTHRAX GERMS IN GRAVES, &C.

Under certain conditions the exposure of the *Bacillus anthracis* to excess of oxygen determines its death. Feltz found that compressed oxygen (15 atmospheres) killed the bacillus, but not the spores. Bert showed that compressed oxygen killed the bacillus, without affecting the qualities of the attendant organic (chemical) poisons. Davaine had shown long previously that the process of putrefaction in the open air led to destruction of bacillus and the loss of infecting power. Later observers have conclusively shown that when the bacillus has formed spores that these can survive the exposure to air and do not break down into an indistinguishable and inert *débris* under the action of oxygen. It has further been shown that the development of spores does not take place in the living animal system, but may take place in suitable conditions after death. The conditions of such growth and of the maintenance of infecting properties may be deduced from the experiments of Buchner recorded above. A free exposure to air and a prompt putrefaction before spores have had time to develop destroys the virus. A very limited supply of air and the retardation of putrefaction afford time for the production of the spores, and is, besides, the precise condition which favors the preservation and increase of their virulence. It will be observed that it is not the entire exclusion of air. Toussaint found that the entire exclusion of the virus from the air in hermetically-sealed glass tubes destroyed its potency in eight or nine days. The condition requisite to its preservation is a restricted supply of air comparable to that met with in the circulating blood or the nutrition liquids of the animal body, or to the flesh infusion in which Buchner transformed the harmless *Bacillus* of *hay* into the deadly *Bacillus* of *anthrax*. It will now be understood why the anthrax poison is preserved in certain soils and graves and destroyed in others. In open, dry, sandy, or gravelly soil, with perfect underdrainage, the bodies of anthrax victims may

be buried with comparative safety. The free permeation of such soils by air insures speedy and perfect putrefaction of the animal product, and the *anthrax bacillus* is at once destroyed, while if spores have been already formed they perish in their turn when transformed by development into the bacillus or chain-forms. In close, impervious, or damp soils, on the other hand, on the heavy clays or even porous soils with an impervious subsoil, in the basins of partially-dried ponds and lakes, on the flat alluvial banks of rivers, on deltas, &c., the poison is preserved for years, and the graves of the victims are especially dangerous. In one such case in Livingston County, New York, on a sandy soil over a heavy clay subsoil, the graves were carefully fenced in by my direction, but nearly a year after, during a rainy period, the liquid oozing out on the river bank between the clay and sand, and opposite one of the fenced graves, was licked by six cattle, all of which promptly perished by anthrax. The grave was now fenced in down to the water and no further deaths occurred. Pasteur has shown the virulence of the soil over such graves a year after interment, the germs being most abundant in the earth casts excreted by the worms which bring the spores from the infecting remains of the carcase beneath. Such soils, it will be seen, furnish the condition of a very limited supply of oxygen dissolved in the water with which they are saturated, or in specially dry seasons admitted between the closely packed particles of the soil, which we have already seen to be essential to the preservation and increase of the infecting properties. Hence it is that some such soils in which the anthrax germ has been once implanted become thenceforth *dead lots*, fatal to any herbivora that may be turned upon them. Every fact connected with the life of the anthrax germ strengthens our confidence in the principle to be deduced from the cultivation experiments of Pasteur on the germ of chicken cholera.

ARGUMENT FROM YELLOW FEVER.

While yellow fever differs from the diseases already named in being less of a contagious affection transmissible from man to man, and more a disease of locality or ships, yet it has some points of resemblance which are not without an instructive bearing on the principle (underlying the potency of certain disease germs) that has occupied our attention. It must be acknowledged at the outset that no *disease germ* has been demonstrated as causative of yellow fever. Yet the history of each epidemic almost of necessity implies the existence of such a germ. The disease is introdoced into a foul tropical seaport by an infected vessel, and the sufferers from the fever, and the infected clothing, cargo, or ballast when landed establish so many centers of infection wherever they may be carried, and from which the poison is spread over one or many cities so long as the conditions are favorable to its development. A mere chemical element cannot multiply in this way, and the propagation of yellow fever through a foul city from a single infected victim demands for its explanation that we assume the existence of a living, self-multiplying organism. It does not affect this position though it is shown that the disease is not transferable indefinitely from man to man, or that the poison cannot undergo increase in the human body; it suffices that it can be carried in or about the human body to multiply and grow indefinitely under the combined influence of damp, heat, and foulness outside the diseased economy. The point I wish to make is that we

have in connection with this disease and causation of it a germ which can grow and increase out of the body and enlarge the area of the epidemic.

That yellow fever can originate on board ship is proved by a large mass of testimony by La Roche, Faget, Anderson, Potter, Hargis, Gamgee, and others (see Hargis' "Yellow Fever," Gamgee's "Yellow Fever a Nautical Disease," &c.). Take one example from Potter: The Busbridge sailed from England for Madras April 15, 1792, and passing through the tropics far west of the Cape de Verde Isles, and in the yellow-fever zone, developed yellow fever on board, though she had touched at no port since leaving England. A still more striking instance is that of the sloop Mary from a healthy port sent into Philadelphia as a prize in 1799. Her cargo was removed, the decks washed, and the hatches and ports shut down without accident to any one employed on her. In this closed state she lay during three weeks of extremely hot weather, when a very offensive smell of bilge water was traced to the ship. Her ports and hatches were thrown open, torrents of foul air rushed out, spreading a suffocating stench for a considerable distance, and a number of cases of yellow fever, the first in the city, developed in persons exposed to the noxious emanations (Caldwell). Here we find the hitherto harmless contents of the hold developing virulent properties under the combined influence of heat, moisture, and a limited supply of oxygen. The fermentation which went on harmlessly so long as the bilge water and other products were exposed to free air developed a deadly product when that air was partially excluded. Many such cases are on record, and show that the living germ, which must be assumed to exist in an innoxious form in the waters of the western tropical Atlantic, acquires its virulence by propagation in a confined area like a closed ship's hold where it can meet with but a limited amount of air. The converse holds equally true, that free exposure to air puts a limit to the virulence of the yellow-fever germs. This is testified by the board of experts appointed by Congress in 1878, by Dr. Vanderpoel, and by all quarantine surgeons.

In yellow fever, therefore, as in the other diseases named, we find further testimony to the truth of the principle that in diseases due to *microphytes*, virulence is often connected with propagation of the germ in a limited supply of oxygen.

EXAMPLE IN ASIATIC CHOLERA.

It is needless here to enter on the question of the true nature of the cholera *contagium*. Suffice it to say, that in the permanence of this disease on certain rich tropical soils (Asiatic), in its conveyance during the summer season to the remotest parts of the world within the tropics and the temperate zones, in the communication of the disease from man to man in a constantly increasing ratio, and in the preservation of the poison with a successive increase and decrease of its virulence after it has passed out of the animal body, we have ample proof of the existence of some kind of disease-germ which increases by a continuous generation. To render this still clearer the annexed table, by Burdon-Sanderson, may be given, setting forth the virulence of the cholera discharges on given days after they have been passed from the bowels and exposed to the free action of the air. The method was this: Pieces of blotting-paper, dipped in the bowel discharges of the cholera patients,

were dried in a free current of air and fed to a given number of mice on each of the first six days after the liquid had been discharged.

Period of decomposition.	Per 100 mice employed in experiment.	
	No. contracted cholera.	No. that died.
First day	11	8
Second day	36	32
Third day	100	21
Fourth day	71	57
Fifth day	40	24
Sixth day	0	0

Here, then, is a manifest increase of virulence for the first three days, showing the capacity of the germ for development outside the animal body, as in the case of yellow fever. The exhaustion of the virulence on the sixth day of development to the action of the air shows the action of the same law that we have seen to hold uniformly in the case of the other poisons examined.

The opposite result of preservation of the cholera poison in a limited amount of air is well shown by the observations of Pettenkofer of Munich. He showed that the following conditions favor the diffusion of the poison and the development of a cholera epidemic, if, indeed, they are not essential to its production. A soil pervious and permeable to water and air, charged with a certain amount of moisture, determined by the presence of stagnant water in the subsoil, and finally with decomposing organic, especially excrementitious, matter. Here, then, we have in the typical soil, favorable to the propagation of the cholera poison, the precise condition found necessary to the preservation of the other disease-germs, namely, growth in an impure and partially deoxygenated atmosphere. In the open air, in Burden-Sanderson's experiments, the virulence was lost after the fifth day, but in the confined interstices of this impure soil it is preserved indefinitely during hot weather, and increases instead of diminishing its infecting properties.

But independently of the condition of soil the deposit of the poison in a confined impure area tends to concentrate and increase its virulence. Thus Orton, Greenboro, Pettenkofer, Barton, and many others have showed that cholera is especially severe and fatal in those infected houses in which a privy odor prevails. The close atmosphere of the sewer serves to secure the preservation of the poison as surely as the interstices of the hot, damp, putrid soil.

EXAMPLE FROM TYPHOID FEVER.

What has just been remarked of cholera and its persistence when the poisonous excreta are thrown into a confined and foul space, is still more characteristic of typhoid fever. Like the germs of cholera, those of typhoid are mainly thrown off by the bowels. If those infecting bowel discharges are exposed on the surface of the soil to the free action of the air, they soon become inocuous. But if they are thrown into a close privy vault, or above all into an unventilated sewer, their virulence increases to a most dangerous extent, and the emanations from such sewers or vaults become incomparably more pestilential than the living

patient or his excreta as just passed from the bowels. Of the infection from sewers and pits, Atkins says:

> The specific virus of typhoid fever may be propagated among healthy persons in one of three ways, namely: 1st, by percolation through the soil into wells that supply drinking water to the inhabitants; 2d, by issuing through defects in the sewers into the air of the inhabited area; or, 3d, by exhalation through the apertures of small ill-trapped water-closets or privies, which are at once the receptacles for the discharges of the sick and the daily resort of the healthy. *When the specific poison thus issues into the air, the atmosphere generated is immeasurably more likely to communicate the disease than that which immediately surrounds the fever patients.*

It may be added that typoid fever was actually increased by the construction in towns of unventilated sewers from which the pent up gases forced themselves back into the houses as the most available means of escape, carrying with them the fever germs in an intensely virulent form. This has now been done away with to a large extent by the ventilation of the sewers, which at once tends to reduce the virulence of the inclosed poison and to do away with the pressure which forced it back into the houses.

That the production of typhoid fever by such sewer emanations is due to the specific poison turned into the sewers from a typhoid fever patient and propagated there, and not alone to the gaseous products of ordinary putrefaction, is clearly shown by the observations of Barlow, that while such simple putrid emanations induce fever and ill health, they do not cause a disease which is transmissable from system to system by contagion. In order to do this it is requisite that the virulent excreta of a typhoid fever patient should be turned into the channel containing the decomposing sewage, but when the virus has been introduced it becomes at once more abundant and more potent, and the whole sewer becomes a prolific generator of disease; the ordinary contents of the sewer in a state of decomposition do not generate the typhoid fever poison, but the sewer serves as the most prolific field for its reproduction whenever the poison is introduced into such putrid masses in the confined space.

In typhoid fever, therefore, we have a most potent illustration of a disease germ which increases its potency for evil as it is grown in a suitable material with a partial supply of air.

SWINE PLAGUE VIRUS MORE VIRULENT WHEN GROWN IN A PARTIALLY AERATED MEDIUM.

The examples furnished above, and which might be materially extended, tend to show that it is a rule with disease-poisons of particular type that a certain limitation in the supply of oxygen to the liquids in which they grow intensifies their infecting qualities and renders them more deadly. It will not be surprising, therefore, if we find that the same principle holds in the case of the specific virus of swine plague, or that the converse is true that growth of this disease-germ with free access to air tends to a steady reduction of the infecting power. In illustrating this subject I must draw upon the cases I have given in the two last reports of the Commissioner of Agriculture (1879 and 1880).

INOCULATION WITH VIRUS MODIFIED BY GROWTH IN FREE AIR AND OTHERWISE.

INOCULATIONS WITH VIRUS CULTIVATED IN COW'S MILK WITH ACCESS TO AIR.

1st. A pig (No. 7, present report) was inoculated with milk which had been infected with swine-plague virus *twenty-four hours* before, and kept at 100° to 120° F., with free access to air through cotton wool. The *effects* were *very slight*, consisting of moderate fever and general but temporary ill health. This pig was subsequently inoculated with infected urine without harm, but succumbed to a virulent liquid that had been kept for five days in a sealed bottle with a limited supply of air.

2d. A pig (No. 8, present report) was inoculated with infected milk which had been kept *two days* in an incubator with access to air as before at a temperature of 100° to 120° F.

The *effect* consisted in a *slight fever* only.

3d. On the eighth day this pig was inoculated with infected milk which had been kept *eight days* in the incubator at a temperature of 100° F., with free access of air through cotton wool.

Again there resulted a *slight fever.*

The animal was subsequently inoculated with virulent pus, without effect, but suffered severely from inoculation with virulent material that had been preserved closely packed in bran, and perished from the injection of an excess of virus kept in a closely sealed bottle with a limited supply of air.

4th. A pig (No. 6, present report) previously inoculated from a vacuum tube, in which virus had been shut up for four days, and which had recovered from the effects, was reinoculated with infected milk which had been kept *eight days* in an incubator with free access to air.

The health was scarcely affected.

This subject afterward suffered severely from inoculation with virus which had been kept three days in wheat bran, and perished from inoculation with excess of virus which had been kept in a sealed bottle with little air.

SUMMARY.

Here, two separate animals inoculated with virus modified by growth in milk with free air, resist the second inoculation with the less virulent matter, but fall victims when the more virulent products are introduced into their systems in excess. A third pig, protected in the same way, suffered fatally from two inoculations with very virulent material. The main point made in these experiments is the material reduction of the virulence of the poison which had been cultivated in milk and air. No evil whatever came from four inoculations with it. The minor point is the resistance of the inoculated system to the minor infections. Inoculation with the more virulent products in excessive amount still proved dangerous or fatal.

INOCULATIONS WITH VIRUS CULTIVATED IN EGG-ALBUMEN WITH FREE ACCESS OF AIR.

5th. A pig (No. 4, present report) was inoculated with infected egg-albumen, the virus having been cultivated in this medium for two generations, for two and seven days respectively, at an ordinary July temperature.

The result was a *very slight* and *temporary fever*.

It was afterwards unsuccessfully inoculated on three separate occasions with virus from a vacuum tube, with virus from a quill, and with virus preserved three days in bran, but perished from an inoculation with virus that had been five days in a sealed bottle with one-fifth its volume of air.

6th. A Suffolk pig (No. 8, report 1880) was inoculated with infected albumen, of the fourth generation, that had stood *six days* in an incubator at a temperature of 98° F., with free access to air through cotton wool.

The *result* on the health was *scarcely* perceptible.

The same pig resisted all subsequent inoculations with more virulent products.

SUMMARY.

The first pig, protected by inoculation with a culture of the virus in egg-albumen in free air, resisted repeated inoculations with virulent matter, and perished only when injected with an excessive amount of the most deadly product I have been able to procure. The second pig showed from first to last no susceptibility to inoculation, so that it may have had a native immunity, and therefore we can deduce nothing certain from its record.

INOCULATIONS WITH VIRUS CULTIVATED IN HUMAN URINE WITH FREE ACCESS OF AIR.

7th. A pig (No 5, present report) was inoculated with infected urine of the second generation, the cultivation having extended over *nine days* in all, and the last over *seven days*, at the ordinary July temperature.

The *result* was *slight fever* only.

This pig was afterward inoculated on three successive occasions with virulent matter without visible harm, but finally succumbed to an inoculation with an excess of infecting peritoneal exudation which had been kept *five days* in a sealed bottle with *one-fifth* its volume of air.

8th. A pig (No. 7, present report) formerly inoculated with infected milk was, on the eighth day, reinoculated, this time with infected urine that had been cultivated eight days in an apparatus allowing the free access of air through cotton wool.

The *result* was only *slight fever*.

Forty-three days thereafter this pig was injected with an excess of peritoneal exudate which had stood three days in a sealed bottle with *one-fifth* its bulk of air. It perished on the thirtieth day.

SUMMARY.

Here we have results identical with those of the egg-albumen virus, perfect resistance of the lighter infections, but prostration by an excess of the most virulent products.

INOCULATIONS WITH VIRUS DRIED ON A QUILL.

9th. A pig (No. 4, 1879) was inoculated with the lung exudate from a case that had died suddenly; *one day* only on the quill.

The result was a *violent attack of swine plague*. The patient was killed on the 18th day when already very low.

10th. A pig (No. 6, 1879) inoculated with lung exudate from a pig

that had been sick a week or two; the virus was dried on a quill for *one day* only.

Result, a *fatal attack*, death occurring on the 27th day.

11th. A pig (No. 2, 1879) inoculated with pulmonary exudate from sick pig; *two days* dried on the quill.

Result, a subacute attack with death on the 26th day.

12th. A pig (No. 3, 1879) was inoculated with lung exudate which had been dried on a quill *five days* since the death of the sick pig.

The result was a limited fever only and recovery.

The same pig afterward survived inoculation with the matter of an intestinal ulcer, but contracted a chronic form of the illness after inoculation with dried infected intestine *five days after the death* of the pig which furnished it.

13th. A pig (No. 9, present report) was inoculated April 23, 1880, with virulent matter (from North Carolina) which had been *four days* dried on a quill.

The result was very slight other than some diarrhea.

On the eleventh day thereafter the same pig was inoculated with virus (from North Carolina) which had been closely *packed in wheat-bran for three days*. It became seriously ill and died on the thirty-sixth day.

14th. A pig (No. 10, present report) inoculated with virus (from North Carolina) which had been dried on a quill for *four days*. There was scarcely any appreciable derangement of health.

An inoculation on the eleventh day with virus preserved for *three days* in bran produced *slight fever* only, but on the fifteenth day thereafter with peritoneal fluid kept five days in a sealed bottle caused *severe illness*, and death on the twenty-fourth day.

15th. A pig (No. 7, 1879) inoculated with lung exudate (from New Jersey) which had been dried on a quill for *six days*.

The result was a severe form of the plague and death on the twenty-fifth day.

SUMMARY.

Two animals inoculated with virus on quill one day old and one with virus two days old suffer a severe attack; two inoculated with virus four days old and one with matter five days old have mild attacks, and finally one animal inoculated with virus six days old suffers a fatal attack. One hundred per cent. perish from dried virus but one and two days old, while 75 per cent. recover from the effects of virus from four to six days old. The virus from New Jersey used when six days old was shown by other cases to be especially virulent, and while it is idle to speculate further in the absence of exact knowledge, there is the strongest presumption that it was present on the quill in a thick layer, and better wrapped up from contact with the atmosphere than in other cases. On the whole, therefore, the inoculation from quills supports the general principle already seen to hold in the case of cultures in different fields.

INOCULATIONS OF SWINE-PLAGUE VIRUS WHICH HAD BEEN PRESERVED WITH A LIMITED SUPPLY OF OXYGEN.

The two forms in which I have tested this experimentally, were (1) by setting aside a small portion of the diseased intestine, lung, or lymphatic gland in a close vessel packed as firmly as possible with dry wheat-bran, and (2) by placing the virulent liquids direct from the diseased animal with one-fifth their volume of air in a sealed bottle, or, by placing the same products in a glass bulb having its outlet tube drawn out to form a narrow orifice (⅓ line) and tightly packed with cotton wool.

INOCULATIONS WITH VIRUS PRESERVED IN DRY WHEAT-BRAN.

15th. A pig (No. 4, Supplemental Report, 1879) unprotected, was inoculated with a portion of diseased intestinal contents that had been *closely packed in bran for one month.*

The result was a *high fever,* great disorder of the bowels, with bloody fæces, and death on the eighteenth day.

16th. A pig (No. 5, Supplemental Report, 1879), unprotected, was inoculated with a portion of diseased intestine and contents that had been closely packed in bran for one month.

The result was a high fever, great disorder of the bowels, petechiæ, and discolored skin. Was killed the twenty-seventh day.

17th. A pig (No. 13, present list) that had been inoculated from a quill, and made to cohabit with a sick pig without much effect, was reinoculated September 3, 1880, with virluent intestine that had been packed three days in dry wheat-bran.

The result was a severe attack of illness and death on the thirty-sixth day.

18th. A pig (No. 2, Supplemental Report, December 19, 1879), fed a portion of intestinal mucous membrane that had been preserved a month in dry bran.

No evil result was *observable.* The same pig suffered severely from inoculation with fresh infected intestine.

19th. A pig (No. 10, present report) that had been inoculated from a quill and suffered from slight fever only was reinoculated September 3, 1880, with infected intestine which had been packed *three days in bran.*

The result was some amount of fever and ill health, which still existed when it was reinoculated fifteen days later with peritoneal exudate preserved five days in a sealed bottle. After this the sickness increased and death resulted on the twenty-fourth day (October 12).

20th. A pig (No. 8, present report) had been inoculated twice with infected milk and once with pus from an inoculation nodule, but without serious illness; was reinoculated September 3 with diseased intestine which had been packed *three days* in wheat-bran.

The result was only moderate illness.

Was again inoculated September 18 with peritoneal exudate from New Jersey, which proved fatal November 10.

21st. A pig (No. 5, present report) inoculated July 3 with infected urine, July 10 with a pulmonary exudate preserved in a vacuum tube, and August 13 with virulent matter dried on a quill, and had, August 10, been placed in an infected pen, was, September 3, inoculated with infecting intestine that had been kept *three days* in bran.

The result was exceedingly *slight fever* if any.

The same subject was inoculated September 18 with excess of peritoneal fluid kept five days in a closely sealed bottle.

22d. A pig (No. 4, present report) inoculated July 3 with infected egg-albumen, July 10 with liquid from a vacuum tube, and August 13 with virus dried on quill, was, September 3, reinoculated with matter which had been closely packed for *three days* in dry bran.

Result, a moderate fever after the two first inoculations, and about the same amount, or rather a higher fever, after the third.

The same pig was, September 18, inoculated with infecting peritoneal fluid which had been *five days* in a closely-sealed bottle, and died 11 days after.

INOCULATIONS WITH VIRUS KEPT IN CLOSED VESSELS WITH ONE-FIFTH THEIR VOLUME OF AIR.

The experiments under this head were conducted, as stated above, in sealed bottles and in glass bulbs with small outlet closely plugged with cotton wool.

It is needless to specify cases, as all animals inoculated with this culture, without exception, suffered severely and even fatally. It is only necessary to refer to Nos. 1, 3, 4, 5, 7, and 14 in the foregoing list.

GENERAL RESULTS.

My cultivation experiments on the virus were commenced in 1878, with the view of ascertaining what organic liquids modified the virulence of the specific poison. As the experiments progressed, it became evident that there was another element affecting the virulence, namely, the free action of the atmosphere on the preserved or cultivated virus. This was indicated in my report for the present year. Since that was written, subsequent facts have lent themselves to strengthen the evidence; and a review of my entire experience with this disease, together with a comparison of this with analogous results observed in the case of the specific poisons of other diseases more or less closely allied to this, have given to the conclusions all the force of a *principle* dominating widely in this class of affections.

The following table will give a "bird's-eye view" of results more striking than any similar amount of writing:

Preservation or culture medium.	No. of generations.	Period of culture.	Air admitted.	No. of subjects.	Results.	
					Slight.	Severe.
Cow's milk	1 to 2	1 to 8 days	Freely	4	4	
Egg-albumen	2 to 4	9 to 19 days	...do	2	2	
Human urine	1 to 2	8 to 9 days	...do	2	2	
Virus dried on quill		1 day		2		2
		2 days		1		1
		4 days		2	2	
		5 days		1	1	
		6 days		1		1
Dry wheat bran	1	30 days	Very limited	3	1	2
	1	3 days	...do	5	3	2
Blood and exudate	1	5 to 11 days	One-fifth volume	6		6

With infected organic liquids kept in free air *eight subjects* were inoculated, and *eight survived*, with only slight illness. With infected organic liquids with a very limited access to air *six subjects* were inoculated and *all died*. With virus dried on quills, so that it can undergo slow changes, only *seven subjects* are inoculated, of which *four* are *severely attacked* and *three slightly*. With fresh diseased organ packed tightly in dry bran, and by reason of its moisture more subject to change, *eight subjects* were inoculated, of which *four suffered severely* and *four slightly*. *Three-fifths* had *slight attacks* when the infecting material had been in the bran but *three days*, and *one-third* only when it had been packed for *thirty days*.

DEDUCTIONS—HYGIENIC AND PROPHYLACTIC.

The above facts and conclusions are pregnant with important suggestions in the field of hygiene and prophylactics.

Dangers of storing up the virus and increasing its potency.—1st. It is evident that we must guard more sedulously than ever against the possible storing up of the virus of swine-plague in confined spaces when it has little access to air, and above all when there is superadded organic matter and moisture which may serve to maintain the vitality and assist in the proliferation of the poison.

Herds crowding in straw-stacks and manure-heaps.—We cannot too severely condemn the current practice of allowing pigs to crowd together by scores and hundreds in the *débris* of rotten straw-stacks and dung heaps, where they lie like sardines in a box, and even piled above each other; the whole, closely enveloped in the masses of decomposing dung or litter, not only shuts out the pure and wholesome air, but generates an abundance of noxious gases to take its place and weaken the system. This doubtless contributes much toward laying the system open to the attack of whatever germ is imported into the herd; it probably does not generate it, otherwise the plague would be even more prevalent than it is. Yet the resulting condition of the blood of the pig, the lack of oxygen, and the growth of the virus in this state of the fluid, in harmony with the principle we have been considering, must enhance its virulence and increase the mortality.

But it is the intensifying of the poison which has passed out of the body which is especially to be feared. Deposits from the breath, skin-exhalations, urine, or dung of the pig, the germs must find in the damp and more firmly-packed lower layers of such refuse, and in the damp, close soil beneath, saturated with decomposing organic matter, the best field for its preservation and for the conservation or increase of its virulence. If the pressure of liquid charged with organic matter could be done away with, the virus would lack for food and would be more readily destroyed. If the air could be freely admitted to all parts of the mass and soil, the virus would soon perish or be transformed into a harmless material. But as it is, this warm bed of the herd supplies the conditions which we have found to be essential to the preservation of the plague-germs and to the increase of its potency.

In connection with this question it is no manifest consideration that among our domestic quadrupeds the pig requires the very largest amount of oxygen in proportion to its body-weight. The following table, condensed from a large one by Colin (*Physiologie Compiarée des Animaux*), will illustrate this:

Animals.	Oxygen consumed in 24 hours per kilogramme of body-weight.	Carbon burned in 24 hours per kilogramme of body-weight.	Carbonic anhydride exhaled in 1 hour per kilogramme of body-weight.
	Grammes.	*Grammes.*	*Litres.*
Horse	13.272	5.080	0.393
Cow	11.040	4.129	0.320
Ass	13.577	5.080	0.393
Pig	29.698	11.166	0.867
Sheep	29.314	7.638	0.593
Dog	28.392	7.621	0.607
Cat	28.475	7.748	0.605
Rabbit	21.192	7.200	0.562

From this it appears that to every pound of his body-weight the pig consumes more than double the amount of oxygen used up by the horse

or cow, and of course reduces a correspondingly greater amount of air to a condition that will not support respiration. If, therefore, the pig is compelled to breathe impure air, as in the conditions above referred to, his blood must sooner be deprived of the oxygen contained in it, and be reduced to that condition which we have seen is most favorable to the virulence and potency of the disease-germ. But the owner should consider that in the conditions named the virus finds the most appropriate media for its propagation and virulence within and without the body alike, and should carefully seclude his stock from exposure to such insalubrious conditions.

CROWDING IN CONFINED SPACES UNDER BARNS.

Hardly less suggestive of the intensifying of the poison is the herding of pigs, and especially in large numbers, in a confined space under barns occupied by other animals. Here the solid and liquid excretions of the stock above pass, to a certain extent, through the floor, and thus mixing with the excretions and exhalations of the pigs, accumulate in the confined area, saturate the ground, and determine constant emanations that deteriorate the air and undermine the health of the animals that crowd together in the close and stagnant atmosphere. The soil under such barns, charged with decomposing organic matter, presents the means for the preservation and germination of the virus, and the paucity of air driven out of the soil by the gaseous products is that best calculated to secure an increase of virulence. Such sleeping-places may, therefore, be set down with manure-heaps and rotten straw stacks as *propagators*, though they may not be *germinators* of the plague. In the present state of the swine industry in the Western States, the swine plague is so wide-spread that the chances are always favorable to the extension of the contagion, and no herd, however well cared for, can be looked upon as safe; yet the danger must be greatly enhanced by that management which so surely contributes to the multiplication and potency of the germ.

CLOSED SPACES BENEATH THE FLOORS.

One of the worst conceivable arrangements in a pig-pen is a wooden floor covering a dark, closed space all but impervious to air. Into such a closed space the liquid excretions will sooner or later penetrate, carrying with them the infecting matter of any diseased animal above. There, over a putrid soil, in a close, foul atmosphere, it has every opportunity of maintaining and increasing its virulence, and of surviving for weeks, months, or years to prove the center of frequent and disastrous outbreaks. The conditions are sufficiently like those connected with the generation of yellow fever and typhus, and of the conservation of these together with cholera and typhoid, to deter any one from constructing or preserving such an incubator of poison.

OBJECTION TO WOODEN FLOORS AND WALLS.

In the light of our facts and observations, every one must perceive the objection to wooden floors and walls in pig-pens, likely to receive the germs of swine plague. The joints and cracks in wooden buildings, and the rotten wood, become filled up with dry or moist excretions, ready to receive and even to propagate the disease germs. Then, above all, in the case of the floors, the wood becomes saturated throughout

with such products, and as it is kept moist the germ once introduced and developing must make increase with a minimum of air, and will thereby retain or strengthen its potency.

To obviate this something might be secured by thoroughly soaking the timbers with oil before constructing the building; but an ideal floor would be an impermeable one—paved with glazed brick, flags, or cobblestones and jointed with Roman cement. The walls constructed of hard burned brick, stone, or cement, could, with such a floor, be frequently flushed with water and kept perfectly pure.

OBJECTION TO CLOSE DRAINS AND LIQUID MANURE PITS.

So-called improvements are often fraught with unseen dangers. Unventilated sewers serve to spread typhoid fever, diphtheria, and cholera; warm, air-tight barns propagate consumption and glanders, and so close covered drains and cesspools, or liquid manure tanks, are liable to spread hog cholera. If these last are indulged in they should be properly ventilated by inlets for fresh air at their lower ends and outlets at their upper, and the latter should on no account be allowed to open into a close pig-pen to befoul its atmosphere. Emanations from such close, confined drains and pits are always unsanitary and injurious to animals requiring such abundance of pure air as do swine, but they must become pre-eminently plague-pits and passages once the hog cholera germ has been introduced into them.

DANGERS FROM RAILROAD CARS AND FROM VESSELS.

It must be apparent that many of the objections to wooden piggeries apply no less to railroad cars. The joints and crevices, the accumulations of filth, and the absence of all systematic disinfection, the constant use of the cars for successive loads of swine, and the impossibility of obtaining perfect drying and aeration in the intervals, all combine to make these vehicles the bearers and disseminators of contagion. The absence of air in the masses of accumulated manure, and in the interstices of the wooden floor or wall will even go far towards adding a new force and malignancy to the poison that may be introduced. In ships and boats there is the additional danger of the close atmosphere between decks and the bilge water in the hold.

Much may be done to obviate the danger by thoroughly soaking the wood-work of the cars and ships, but especially the floors, in oil, which will prevent the imbibition of other liquids. But in an infected country nothing can replace the thorough cleansing and disinfection of these cars and ships before they are to be used on any occasion for the conveyance of store animals.

RAILROAD AND MARKET YARDS AND BUILDINGS.

As the rendezvous for great herds of swine these are surrounded by all the dangers of wooden piggeries and the additional risks of infection attended on the railroad cars. The virulent droppings from one herd remain in the wood-work, joints, and cracks, in the intervals between the paving stones, in the closed spaces beneath the floors, and in drains, &c., to infect other herds which pass through the same place in rapid succession. In the accumulated refuse, and especially in the closed buildings and drains, there is the special danger of the specific poison attaining increased virulence and malignity and spreading a more

inveterate type of the malady than that from which it was derived. The minute precautions advised for cars and boats are equally demanded for public yards and buildings to be used for store swine.

VARYING SEASONS WILL FAVOR A VARYING MORTALITY.

It is not our purpose now to estimate the influence of electrical disturbances on the growth and quality of the poison, as that has not entered into our premises. In passing over these, however, we must not be held to ignore the great influence exerted on fermentations by varying states of electrical tension, and the strong presumption that a poison, such as that of hog cholera, is similarly affected, and especially where outside the body. What we would especially call attention to is the varying condition of the soil as serving to preserve or modify the growth of the disease poison.

WHY SUMMER IS THE MOST DANGEROUS SEASON.

Various considerations will show the especial danger of summer. In winter the soil is bound up in frost, and even though the disease germ may be present in the earth, it is closely sealed and usually harmless. The hard surface cannot be broken up by *rooting*, and therefore the germ cannot be set free until the occurrence of the thaw. The germ cannot multiply in the soil, being laid up, not dead, but inactive like the dried and stored seed, ready to start a new growth and increase when subjected to the warmth and moisture of spring and summer. Thus it is that the disease often disappears during the winter months but breaks out anew on the return of genial weather.

In summer, on the other hand, the frozen germ in the soil, building, or other place, is free to grow and multiply, and though buried more or less deeply it is constantly liable to be set free by the *rooting* of the hog. The germs thus *rooted* up from a depth in the soil are likely to be far more dangerous than those that may have been left on the surface, having met with little air to determine a salutary modification. In summer, too, the hog exposed to the scorching rays of the sun is rendered feverish and more susceptible to the action of disease poisons. The air that he breathes is much more rarefied, contains far less oxygen in a given volume, and thus the aeration of the blood is likely to be less perfect than in colder weather, and the blood to prove more conducive to the production of a malignant germ. If the hogs are fed, as is too often the case, even in the extreme heat of summer, almost exclusively on Indian corn of the preceding year's crop, this adds its quota of costiveness, intestinal irritation, and fever, to favor the disease in its worst type. Finally, it need not be overlooked that summer is the season of the greatest number of hogs, and especially of young hogs that have never had the plague, and are therefore especially susceptible to its ravages.

DRY SEASONS ON PARTICULAR SOILS.

In dry, hot seasons not only are clay and other soils covered by a hard beaten crust comparatively impervious to air, but the soil beneath, also dry, is filled with the gaseous products of organic decay, which drive out the wholesome atmospheric air and prevent its entrance. The germs lodged in such a soil at a sufficient depth to bring them in contact with some moisture are in precisely those conditions of a limited amount of oxygen in which they can develop their most redoubtable

qualities. If the soil in question is naturally rich in organic matter, or if, as is usually the case in piggeries, it has been thoroughly charged with the secretions of the animals, the conditions are at their worst, as the organic matter furnishes food for the growth of the germ and the comparative absence of air tends to its more malignant development.

The drying up of drains, pools, and pits during summer and autumn further favors the escape of germs that may have remained in the soil beneath harmless, until they could rise on the air in the gaseous emanations or be grubbed up by the snout of the pig. So with the virulent germs in the wood-work and beneath the floors. These may easily escape in infinitessimal particles from the open and cracking wood or the dry area beneath, though they had been hitherto bound up by the moisture.

EFFECT OF WET SEASONS ON CERTAIN SOILS.

Specially wet seasons operate in another way. By the heavy rainfall the soil is filled with water. If both soil and subsoil is gravelly or sandy, and if the fall is sufficient for good drainage, this soon passes off, and the germs are washed away, or, if not, are early disinfected by the action of the air. But in the rich alluvial soil, and clay which is more retentive of moisture, and in even the sandy and gravelly surface soils that have a subsoil of clay or other impervious material, or that are so low or so level that natural drainage is impossible, there is a water-logged condition approaching more or less near to the surface, and just so far as the soil is charged with water it is to a large extent emptied of air. The water-logged soil can only retain as much oxygen as the water will dissolve, and while at the best this must be limited, it must be diminished in exact ratio with the pressure of the gases derived from the earth. It must be manifest, therefore, that soils that are at once rich in organic matter and from any cause retentive of water, wet seasons must often add to the potency of the swine-plague germ by determining its growth in a limited supply of air.

VALUE OF LOOSE DRY EARTH AS A DISINFECTANT.

This appears to depend largely on its antiseptic and deodorizing properties. Finely-powdered dry loam or clay is a direct antiseptic, and has the power of absorbing the noxious gases produced by organic decomposition and the growth of bacteria. It is besides porous in an eminent degree, and this transmits through its substance a large amount of atmospheric air and determines the less obnoxious fermentation. Hence in earth closets the disagreeable odor may be entirely suppressed; in the case of anthrax carcasses the virulence may in time disappear; and in hog cholera the same good result may finally be attained. But it must be observed it is the dry, pulverulent, porous earth alone that will act in this way. Moisten it and pack it firmly and its good qualities may be at once exchanged for evil ones, and it may become a dangerous propagator in place of a destroyer of infection. Dry earth is not a potent and speedy disinfectant like chloride of zinc or lime; it will act slowly in this way if perfectly dry, open, and porous, but saturated with moisture or closely compressed, its good qualities are in the main lost. It may be used in certain cases as an auxiliary to other disinfectants, and its action is mainly valuable as showing how the porous dry soils are slowly but permanently destructive to such poisons as those of anthrax, chicken cholera, and swine plague.

PROTECTION BY INOCULATION WITH THE MITIGATED VIRUS.

What has been said on inoculations with the two forms of virus grown respectively in muscle and little air seems to establish the fact that the first-named form produces a mild type of the disease, rarely or never fatal, and that this protects to a reasonable extent against any subsequent attack from exposure to infection. In short, we seem to have here placed in our hands a means of protecting individual hogs and herds against heavy mortality from swine plague, which yearly claims its tens of thousands of victims. We have something apparently as valuable as the protective inoculation against small-pox, or lung plague, or even chicken cholera. It is not enough, however, to set forth the benefits; the drawbacks also must be advanced.

DRAWBACKS TO PROTECTIVE INOCULATION WITH MITIGATED VIRUS.

1st. *The protective inoculation retards growth and thriving.*—Just how far this will affect the animal I am not yet prepared to say, yet in my cases it kept back the subject for one or several weeks. In a short-lived animal like the pig this is of some consequence, though admittedly of in comparably less than the present losses from hog cholera.

2d. *The method is a cause of the preservation of the disease-germ.*—This is a much more weighty objection. To protect a herd that is liable to be exposed to infection we must transmit to each animal the germ of the plague itself. The germ it is true will prove all but harmless to the animals inoculated, but it will propagate in their systems and be deposited in their dwellings and yards, and if in either it meets with those conditions, which will serve to increase its virulence, it will be liable to speedily assume its deadly form and type. Let the living germ be put up in wood-work, or beneath it in drain or pit, in litter or manure, in puddled or water-logged soil, as above described, and it may soon be transformed from a benignant to a malignant poison. Let this once take place, and every new pig introduced by birth or otherwise is liable to contract the fatal form of the malady and to become the starting point for a new and disastrous outbreak. The same transformation to a virulent type may take place spontaneously in the bodies of certain animals on account of coexistent fever or other bodily disorder.

Protective inoculation with this mitigated virus is too closely allied to the inoculation of flocks with sheep-pox or of human beings with small-pox. There can be no doubt that the habitual high mortality of these diseases may be almost entirely obviated in this way, but the disease-germ is reproduced to an indefinite extent, and there is ever the danger of uninoculated and susceptible subjects from outside or born in the place contracting the malady in its most deadly form. So of the inoculation for swine plague with even mitigated virus. To render it perfectly safe it must be done under disinfecting precautions. The subjects should be kept in a building with paved or cement floors and lower walls, so that there may be no opportunity for the storing up of the disease-germ; their excretions must be regularly and thoroughly disinfected; all drains must be carefully attended to in the same way, and finally, on full recovery, the place must be subjected to a thorough disinfection. It might doubtless be often safely accomplished on open porous soils naturally well drained, where the germs of the disease would be early destroyed, and where there was no wet spot, pond, stream, building, or other place where the virus could be shut up and preserved or intensified. The greatest care, too, would be needful to prevent the escape of

the infected or the approach of other animals, and to seclude the ground from pigs, sheep, rabbits, and other susceptible creatures for a length of time after a full recovery.

INOCULATION OF HERDS THAT ARE ALREADY INFECTED.

It can rarely be desirable to inoculate herds, unless they already have the infection in their midst, or are so much exposed that they can scarcely fail to contract the malady if left to themselves. But in these conditions it may evidently be adopted with decided advantage if intelligently carried out.

The first measure would be to remove the whole herd from the buildings and inclosures in which the more virulent germ had been deposited, excepting only such pigs as show by their elevated temperature, enlarged glands, cough, disturbed digestion, discolored skin, or other symptom, that they were already infected. They should be placed in a building or place as above indicated, where a subsequent thorough disinfection could be applied. They should be carefully watched after inoculation, and if any one has developed the malignant type of the disease it should be at once removed from the herd and destroyed or otherwise safely taken care of.

Pains should be taken to supply pure air and surroundings, to avoid extremes of heat and cold, to give gently-laxative and easily-digested food, and to correct any unhealthy condition of the functions, above all of digestion. Finally, when all have recovered, disinfection of the premises should be conducted in a very thorough manner.

2.—PROTECTIVE INFLUENCE OF THE CHEMICAL PRODUCTS OF THE SWINE-PLAGUE GERM.

Bacteria intoxication and bacteria infection.—In all diseases caused by microphytes, there are two associated but distinct deleterious agents to be taken into account: 1st, the organism which is introduced from without and multiplies in the body of the patient; 2d, the chemical products elaborated by the growth and increase of the imported organism at the expense of the vital liquids. The two have been aptly named bacteria infection and bacteria intoxication. Each may be injurious, and even fatal, yet each has its special mode of action and its limitations, so that we can estimate with a reasonable amount of certainty the probable results in the two cases.

In *bacteria* infection the self-multiplying organism is introduced into the body, and if it finds a suitable field for its growth it undergoes an indefinite increase, and may undermine the health or destroy life in one of various ways; for example, by accumulating in the capillaries, arresting the flow of blood and abolishing the functions of vital organs, or leading to local abscess or gangrene; by abstracting oxygen and other essential elements from the blood, and resolving this vital fluid into a poisonous in place of a life-giving stream; or by reproducing itself in myriads, elaborating a vast amount of noxious chemical products and killing by poisoning. The *bacteria intoxication* or *poisoning*, on the other hand, is affected directly by the products of the growth of the bacteria, or in other words, by a chemical compound incapable in itself of reproducing or increasing its substance. The respective powers and limitations of the two poisons may thus be mapped out with great clearness.

It is manifest that from *bacteria infection* may be derived nearly all

the evil results of *bacteria intoxication*, in addition to certain pernicious actions peculiarly its own. The germ being a living organism, with limitless powers of growth, it is manifest that apart from the power of the system to support it, there can be no bound to the amount of chemical poisonous product it may generate, and thus to its own special work of destruction of the essential constituents of the blood, deoxidation of the vital fluid, plugging of vessels, local abscess and gangrene, it must ever add the poisonous influences of its purely chemical products. But it has its limitations as well, which do not belong to its products. In several bacteridian diseases the system will not sustain nor nourish the bacteria with the same readiness a second time if at all. The system that has once sustained an attack does not readily succumb to the same again. An incompatibility or antagonism has been established between the system thus protected and the bacterium, and henceforth the system may be repeatedly inoculated with the bacterium with the most perfect impunity. This cannot be said of the chemical products of the bacteria growth. These, like all chemical poisons, will act again and again upon the same system with little difference in effect, and if a partial tolerance of their presence is acquired it can only be to a limited extent and after long exposure to their action, as tipplers acquire a tolerance of alcohol, or opium or arsenic eaters of these respective poisons. Kill the mycrophytes in the infecting bacteria liquids, and the chemical products will act in exact ratio with the dose administered, and no amount of experience with the poison will prevent an excessive dose proving fatal. The action moreover will be prompt, and if it does not produce fatal results at an early stage it will gradually subside, for since the poison cannot multiply itself its effects must steadily decrease with its elimination from the system. With *bacteria infection*, on the other hand, the evil effects must be somewhat delayed to allow of the reproduction of the germ and the production of the chemical poison, and thus the disorder of the system will undergo a progressive development. In another respect we may conceive of the bacteria infection being limited in its evil results. If the bacteria increase slowly the system will be likely to become somewhat habituated to the influence of the poison and insusceptible to it, so that by the time the disease reaches its height the system may be able to bear with impunity a quantity of the poison which it could not have tolerated had the same amount been introduced suddenly and before the economy had become inured to its influence.

In illustration of the separate action of the bacteria and their chemical products, Koch's experiments on mice with putrid fluids are most instructive. These were made with putrid liquid, but serve none the less to illustrate bacteridian poisoning. Koch injected putrid liquids under the skin of the mouse, and found when the amount used had been excessive that the mouse died in a few hours from the effects of the chemical poison, and that not a bacillus could be found in the blood within the vessels. If, on the other hand, a minimum amount of the putrid liquid was used, as by making a slight scratch with a lancet, the tip of which had been dipped in the liquid, and if the mouse survived the primary danger of death by the chemical poison it died in the course of about two days of bacteridian infection, and the blood was found swarming with bacteria. Similarly, Chauveau found that Algerian sheep, that are naturally insusceptible to *anthrax*, and which had successfully resisted inoculation with a minimum amount of the virus, fell victims to the disease if an excess of the poison were injected under the skin, or if a second and third inoculation were practiced before the effects of the first had passed off. Finally, Cossar, Ewart, and Bur-

don-Sanderson found that when anthrax liquids had been devitalized by exposure for some time to compressed oxygen (12 atmospheres), and when the germs (bacillus, and spores) had lost their power of propagation and increase, the fluid still proved injurious, and even fatal to animals on which it was inoculated. With the vital germ destroyed, these evil effects could only come of the remaining chemical poisonous products, which retained their original potency.

My own experiments on the virus of hog-cholera tend to establish the same fact in that disease. When I had subjected the virulent fluids for an hour to a temperature oscillating between 130° and 140° F., and then inoculated them on the pig, I found that the result was a certain amount of constitutional disorder and ill health, which did not, however, go on to a fatal issue. Here I presume, though I cannot prove, that the disease germ had perished, and that the effects were due to the chemical products alone. Similarly, when I injected into the system large quantities of the virulent fluids, I found that death took place almost without exception, even in animals that had resisted ordinary inoculations. Of this mortality we may find an explanation in the febrile state of the system, induced by the presence of the chemical poison. Davaine found that Guinea pigs died in summer from the inoculation with $\frac{1}{1000}$ of the amount of putrid blood found necessary to kill the same animals in winter. This may be partly due to the excess of bacteria present in the air in summer, and introduced into the putrefying fluid, but was doubtless further influenced by the relaxed and susceptible condition of the system of the animals operated on. The observations of Chauveau and my own, that the inoculation with an excess of the virulent bacteria fluid will overcome the resisting power of a comparatively insusceptible animal and induce a fatal result, tend to establish the same conclusion. The organic poison in such cases would undoubtedly induce fever, and the derangement of functions and assimilation attendant on the fever would break down the vital barriers and cause the blood globules and tissues to succumb to the attacks of the bacteria. The deduction is further corroborated by the morbid and even fatal results obtained by repeated inoculations at short intervals with virulent bacteria fluids. Chauveau's experiments on Algerian sheep with anthrax fluids and my own on pigs with swine-plague virus show clearly that the introduction into the system of fresh virulent bacteria fluids before a former inoculation had spent itself and had its products eliminated, enhanced the violence of the attack and often induced a fatal result. Here it is not the increase in the number of the bacteria alone, nor the access of fresh, and therefore more potent, germs that have the evil effects, for in the infected system there is practically no limit to the multiplication of the bacteria, and these, in place of being weakened, are often rendered more potent by passing through a succession of animal systems. It is probably largely due to a sudden access of the irritating chemical products along with the fresh bacteria.

Is future protection secured by the action of the chemical products alone, or is the presence in the system of the bacteria essential?—If we knew positively on what the protection from a second attack of the same infectious disease immediately depends, we could give a scientific answer to this question, but while our views of the mode of such protection are merely hypothetical we can only indulge in inferences which may be more or less reasonable. Some have supposed that there is eliminated from the system during the first attack some element, the presence of which is necessary to the maintenance and propagation of the disease germ, but they fail to show why this particular element is not in itself

reproduced in after life as it was in time past. Others hold that the chemical products of the growth of the bacteria are left in the system and prove fatal to the bacteria germs if again introduced. But this is negatived by the fact that these same virulent bacteria continue to grow in the same vessel, and in spite of the presence of their chemical products, if fresh infusion of meat is introduced. Moreover, both of these assumptions appear to be disproved by the fact that a large dose of the virulent bacteria fluid in a refractory system will overcome the apparent immunity and lay the animal under the sway of the disease. If the immunity were due, either to the abstraction of an element essential to the bacteria or the presence of a product inimical to them, the results would be of an entirely opposite kind, and the subject would be as much proof against a large dose as a small one. A third hypothesis, at one time supported by Toussaint in the case of anthrax, was that, by the earlier attack, inflammation of the lymphatic glands was induced and an amount of condensation, which in the future enabled them to filter the bacteria out of the liquids passing through them, and thus to prevent the infection of the general system. This view was thought to receive strong confirmation from the fact that bacteria, thrown into the blood, are usually filtered out of it by the capillaries in the course of a few hours, and that the blood of the fœtus in the womb of a pregnant animal has never been found to contain the bacillus anthracis, though the dam may have perished with that disease and though her blood may have swarmed with the germs. But the advocates of this hypothesis overlooked the facts that the occurrence of inflammation, condensation, enlargement, and other structural changes of the lymphatic glands (as from tuberculosis, cancer, lymphadenoma, &c.,) offered no protection against a subsequent attack of anthrax; and that though the bacteria thrown into the blood disappeared within a few hours, they reappeared later in countless numbers when they had had time for reproduction in the circulatory system.

Then with regard to the *fœtus in utero* there is another influence which curiously enough has hitherto escaped recognition by all observers and writers on this subject. *The fœtus is essentially a carnivorous animal;* it lives solely on the products elaborated for it in the maternal system, and thus has a claim to the comparative immunity from anthrax which appears to pertain to all animals that feed on flesh alone. This immunity has been shown to belong less to the germs than to the kind of food furnished. Thus foxes and rats were alike refractory to anthrax when their diet was restricted to flesh, but both fell easy victims if first fed for some time on vegetable food. Like the carnivorous animal the *fœtus in utero* is sustained exclusively by the products of the animal economy, and it is much more reasonable to suppose that in this lies the secret of its immunity from anthrax, than that the fœtal membranes form a filter more efficient than the mucous membranes and skin show themselves to be in the case of the mother. The only other hypothesis that need be mentioned maintains that the organized elements of the body—blood globules, nuclei, &c.—by reason of their first exposure to the poison become physiologically insusceptible to its pernicious effects, just as a drunkard becomes proof against large doses of alcohol, an opium eater against morphia, or a smoker against tobacco. In each of these cases the susceptibility to the poison is not altogether lost, but a large dose may still prove fatal, and this is precisely what holds also in the bacteridian diseases. It may be opposed to this view that the blood globules, nuclei, and other living and assimilating elements of the body are not permanent but are continually changing, new generations con-

Report Commissioner of Agriculture for 1880.

SWINE PLAGUE.

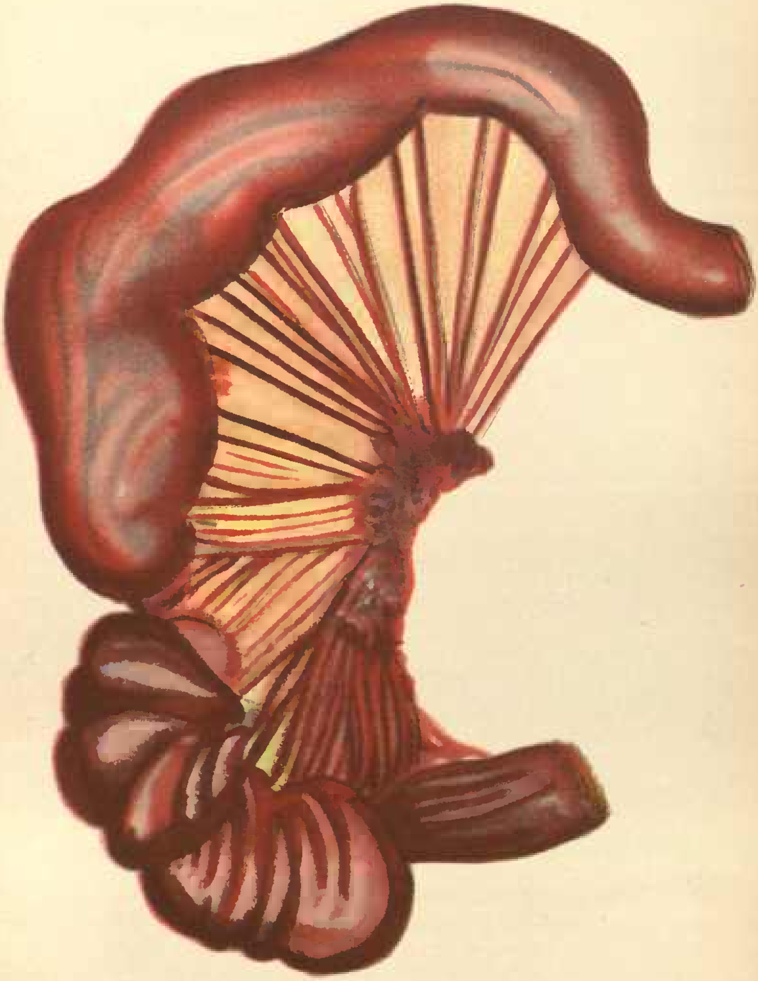
Investigations by Dr. James Law. Plate I.

Mucous Membrane of small Intestine with blood effused on its surface.

A. Hoen & Co. Lithocaustic. Baltimore

SWINE PLAGUE.

Investigations by Dr. James Law. Plate II.



Invagination of small Intestine in white pig No.4, which died Sept. 29. 1880. Shows whole intestine and mesentery violently inflamed and blood effused into the lumen.

A. Hoen & Co. Lithocaustic Baltimore

SWINE PLAGUE.

Investigations by Dr. James Law. Plate III

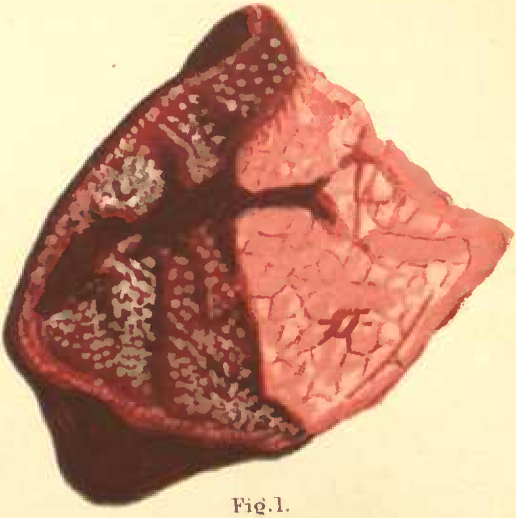


Fig. 1.
Portion of Right Lung of small white pig No. 5, which died Oct. 12, 1880. Dark part of parenchyma is consolidated and studded with miliary tubercles.

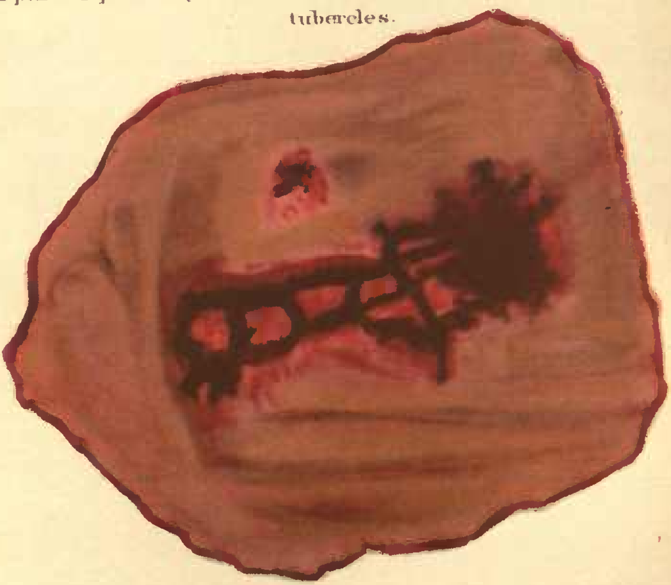
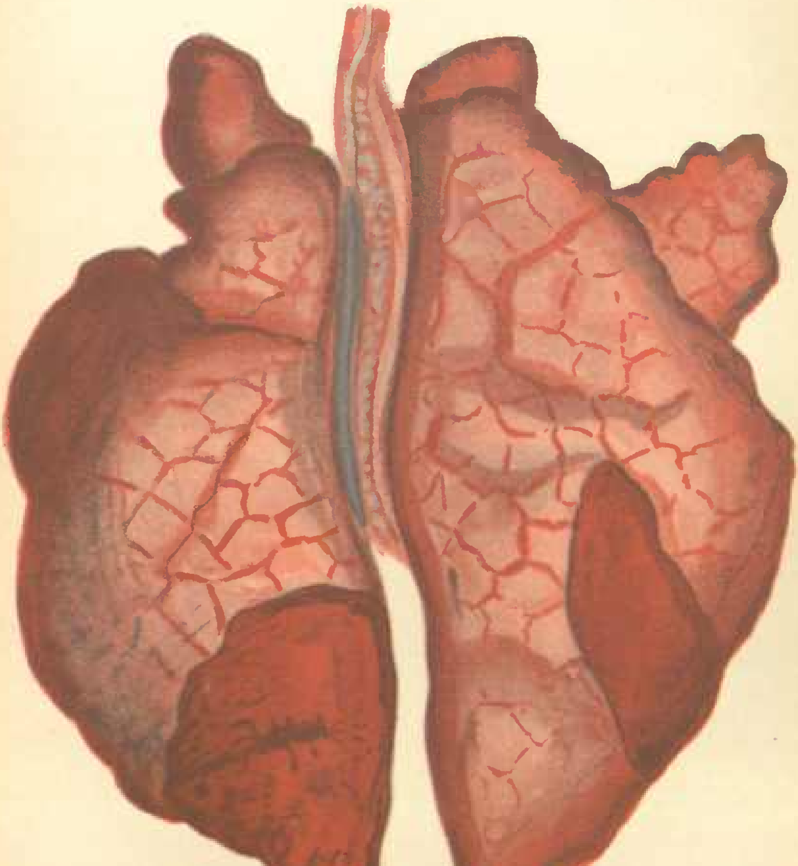


Fig. 2.
Portion of mucous membrane from the Great Curvature of the stomach of the same pig. General congestion, with patches of blood extravasation and erosion.

A.Hoen & Co. Lithocaustic Baltimore

SWINE PLAGUE.

Investigations by Dr. James Law. Plate IV.



Lungs of large white pig No. 9, which died Oct. 9, 1880. Hepatised portions stand out clearly by margins of lobules.

A.Hoen & Co Lithocaustic Baltimore

SWINE PLAGUE

Investigations by Dr. James Law. Plate V.

Fig 1

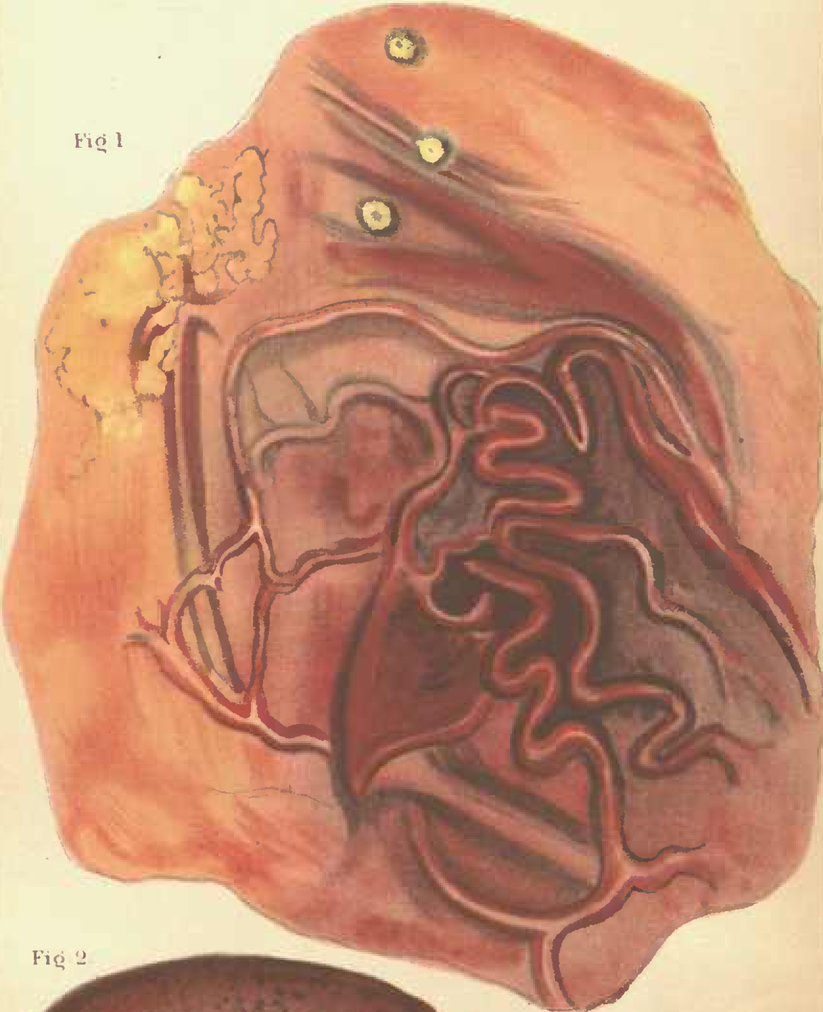


Fig 2

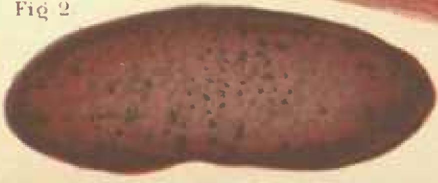


Fig 1.

Mucous surface of Great Curvature of pig No 9, died Oct. 9, 1880. The dark congested rugæ correspond to the curvature; the circular ulcers and yellowish false membrane are on the pyloric side

Fig 2.

Kidney of same pig

A.Hoen & Co. Lithocaustic, Baltimore

SWINE PLAGUE.

Investigations by Dr. James Law. Plate VI.

Mucous surface of Rectum of pig No. 9, which died Oct. 9, 1880.

A. Hoen & Co. Lithocaustic Baltimore

SWINE PLAGUE.

Investigations by Dr. James Law. Plate VII.

Fig. 1.
Ilio-cæcal valve and portion of cæcum of pig No. 9, which died Oct. 9, 1880.

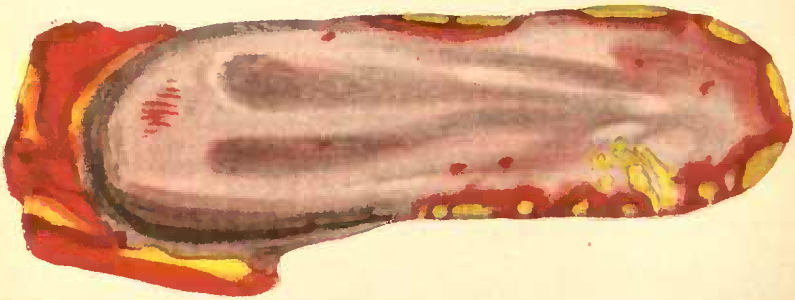
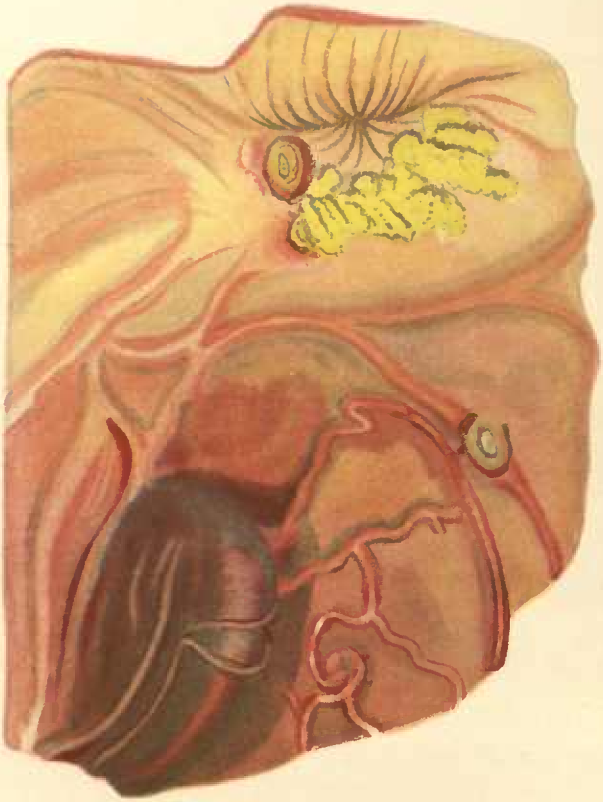


Fig. 2.
Tongue of small white pig No. 10, which died Oct. 12, 1880. Shows numerous ulcers and petechiæ.

A.Hoen & Co. Lithocaustic. Baltimore

SWINE PLAGUE.

Investigations by Dr. James Law. Plate VIII.

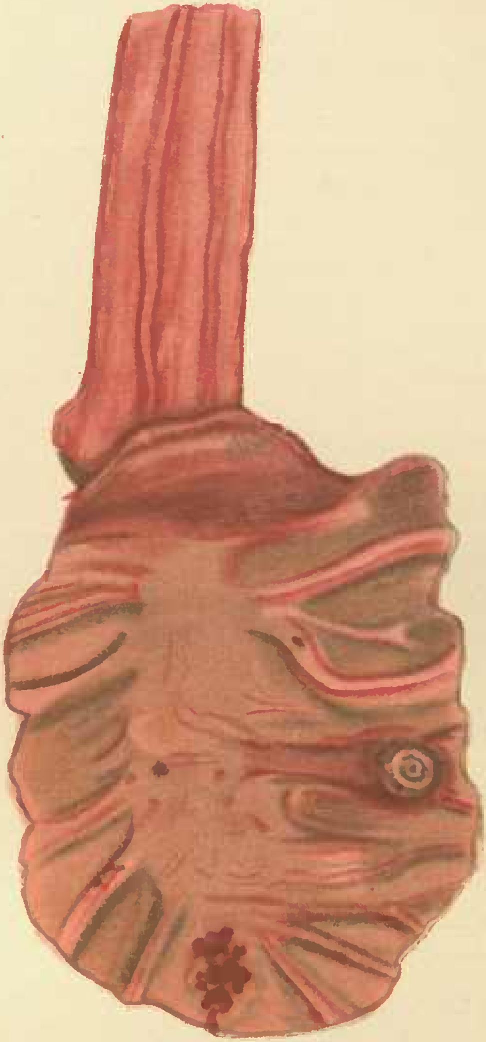


Portion of stomach of small white pig No. 10. which died Oct 12. 1880 The dark congested portion on the Great Curvature; the ulcers and false membranes near the pylorus.

A.Hoen & Co Lithocaustic Baltimore

SWINE PLAGUE.

Investigations by Dr. James Law. Plate IX



Ilio-cæcal valve and part of cæcum of small white pig No. 10, which died Oct 12. 1880. Cæcum shows a circular ulcer and various erosions.

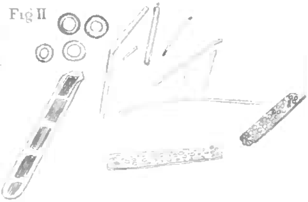
SWINE PLAGUE.

Microscopic Investigations by Dr. James Law.

Fig. I.

Bacteria from the lung exudate of sick pig killed June 23 1880, at Horseheads Hartnack No 10. Immersion Tube lengthened

Fig II



From the milk tank for the piggery where the sick pigs were kept.
Hartnack No 10. Tube drawn out.

Fig. III.

Milk, whey, &c. from feeding trough of the piggery. The bacteria have lively movements. Bacteria and Oil globules
Hartnack No 10 Immersion.

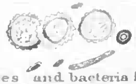
Fig IV.

Bacteria cell and granules from liquids of inoculation swelling of No 2, Aug. 13 1880
Hartnack No 10 Immersion.

Fig V

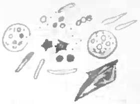
Bacteria in egg albumen, inoculated six days before, and kept at ordinary temperature in July.
Hartnack No. 10 Immersion.

Fig. VI.



Blood globules and bacteria from virulent blood sent in vacuum tube from North Carolina.
Hartnack No. 10 Immersion.

Fig. VII.



Objects seen in the pus of inoculation abscess of No. 4. x 250.

Fig. VIII.

Bacteria in urine of man inoculated with virus of Swine Plague, seven days before, and kept in apparatus closed by cotten wool at ordinary temperature in July. Motions lively.
Hartnack No. 10 Immersion.

Fig IX.

Bacteria from milk inoculated with hog cholera 48 hours before. Second generation Hartnack No. 10 Immersion.

Fig. X.

Bacteria &c. from egg albumen inoculated three days before with Swine Plague virus and kept in apparatus at ordinary July temperature. No motion.
Hartnack No. 10. Immersion.

Fig XI.

Bacteria found in the urine of pig No. 1 just after death. July 17, 1880. Lively movements.
Hartnack No. 10 Immersion.

Fig XII.

Bacteria from the blood of dead pig No. 9. Lively movements
Hartnack No. 10. Immersion.

A. Hoen & Co. Lithocaustic, Baltimore

stantly taking the place of the old, and that it is irrational to suppose that this refractory habit towards a particular poison can be transmitted through ten, twenty, fifty, or one hundred generations without being exhausted, and that if this can be the case in the individual system it should be equally true for the family, for as the offspring results from the growth of two vital elements of the parents, it should inherit the acquired immunity to a particular disease as it inherits the other personal attributes of the parent. But the cases are not exactly parallel. The germs supplied by the parents as the starting point of the future animal, though they have within them all the powers of nutrition, growth, and development which should issue in a new being, the counterpart of its parents, are yet susceptible of changes and peculiarities of development that do not belong to the nuclei which preside over the nutrition and growth of the tissues of the fully-formed animal body.

The embryonic cell at first grows and multiplies only without any manifest tendency to differentiation. Later, when the different organs of the new being are to be formed, the cells take on powers according to their location; one set of cells build up vessels, another set produce nervous tissue, a third set cartilage, a fourth, muscle, a fifth, tendon, and so on until the entire body is completed in all its harmony and symmetry. But with the formation of the different tissues the cells that preside over their formation have their functions narrowly restricted to certain well-defined limits. At an earlier stage anything that interferes with the growth and nutrition of the embryonic cell will cause an arrest, redundancy, or modification of the future animal; thus distortions, malformations, and monstrosities of the chick may be determined by varnishing in various ways the shell of an egg. But when the body has once been formed out of these plastic and unstable embryonic cells, their descendants can only, in health, produce the tissue in the midst of which they lie and that only to a limited extent and in a definite form. The nuclei of muscle, nerve, and bone can respectively build up but muscle, nerve, and bone, and the form of the particular muscle, nerve, or bone in which the lot of each has been cast. When we thus see the progeny of the germ cell or the embryonic cell losing all the powers of varied growth and development which were inherent in their parents and limited for the future to one definite and invariable process in nutrition and growth, we can well imagine how the same germ cells in developing into the animal body should part also with that refractory attitude toward a specific disease which was the prerogative of the parent organism.

This view is further strengthened by the fact that though an animal that has acquired an immunity from a specific disease afterward produces offspring which are susceptible to the disease in question, yet it has been shown in the case of anthrax, that if such immunity on the part of the parent has been acquired by a non-fatal attack of the affection during advanced pregnancy, the preservative effect is extended to the fœtus as well. Here the fœtus has advanced beyond the condition of an ovum, or of simple embryonic cells or tissue, and is already well formed, with all its differentiated bones, muscles, tendons, brain, nerves, vessels, and viscera. The nuclei presiding over the growth of these different structures are henceforth fixed in their powers, and any habitude impressed upon them may now be permanently preserved just as it is in the adult animal.

This consideration serves to fortify the doctrine that the immunity from a contagious disease acquired by a first attack is due to a habit, or acquired power of endurance or resistance on the part of the living cells or nuclei of the animal body. The doctrine it is true is not abso-

lutely proved—it must remain as a hypothetical proposition; but it better accords with and explains observed facts, and is liable to fewer objections than any theory on the subject that has come under our notice. We may accept it therefore as a working theory subject to revision at any future time, should further developments demand this.

To return to our question. Do the observed facts accord best with the idea that protection is acquired by the action of the chemical products of the bacteria alone, or is the presence in the system of the bacteria essential? As the question appears to us everything serves to support the first conclusion. *A priori*, a dead bacterium can no more render the system or the tissue non-receptive of the live bacterium than can any other similar infinitesimal particle of dead matter. Again, if it were merely the mechanical effects of the bacteria in the capillary blood-vessels and tissues that secured the protection, one bacterium should be absolutely protective against the attack of another—the animal that has suffered from anthrax should be insusceptible to septicæmia and vice versa. But excepting in the case of anthrax and chicken cholera no such mutual vicarious action has been shown to exist.

The facts attending the acquired immunity of the advanced but unborn offspring of an anthrax mother seem to be almost conclusive on this question. The blood of the dam may be swarming with bacteria, but these have never been found in the blood of the fœtus. It is only reasonable to conclude that they have never entered the body of the fœtus, or if otherwise that they have perished very soon after they entered. The chemical products, on the other hand, being soluble in the vital fluids presumably enter the fœtal system along with the maternal secretions. The offspring when born proves refractory to anthrax, so that there is the strongest presumption that it has been fortified by the action of the chemical products of the anthrax upon its system before birth. In this case immunity cannot well have resulted from any action of the growing and multiplying bacteria on the blood or living tissues, for the evidence is all opposed to the idea of their presence, at any time, in the fœtal system, much more to their growth and propagation there. Yet here unquestionably the disease in the mother has produced an insusceptibility in the fœtus, such as would occur had it been itself the subject of the disease. It follows almost of necessity that the introduction into the system of the chemical products of the bacteria is equivalent in a protective sense to the introduction of the bacteria themselves. But the mere chemical products cannot undergo increase in the system; therefore, we can graduate the dose of these as safely as we can a dose of opium or rhubarb.

With this presumptive evidence we are prepared to study the direct results of the introduction into the system of the chemical products of anthrax and swine plague made with the view of securing an insusceptibility to these respective diseases in the future.

Toussaint's results.—Toussaint employed two different methods for the removal and destruction of the bacteria from his anthrax liquids. First, he filtered the anthrax blood through a linen cloth and ten or twelve folds of filter-paper, having first defibrinated it to secure readier filtration. But the method mostly successful sometimes failed on account of the escape of bacteria through the filter, and was always difficult to manipulate by reason of the clogging of the filter. Second, he sought to destroy the vitality of the bacteria by heating the anthrax liquid for fifteen minutes to a temperature of 55° centigrade (131° F.). To prevent

further change he then added carbolic acid at the rate of a drop or two to each ounce of the heated liquid.

Whether Toussaint succeeded in destroying the vitality of all the bacteria by this last method may well be questioned. Yet the results showed that he had at least so far reduced their vitality and virulence that they could as a rule be thrown into the system of an animal without producing fatal results, but with the effect of rendering that system refractory to the disease for the future. In his first experiment five sheep were inoculated with the *supposed devitalized* anthrax blood. Later these were inoculated with the fresh anthrax blood of a rabbit. One died and four survived. The four sheep were now again injected with the devitalized blood of the dead sheep, and though they have been twice since inoculated with fresh virulent blood they have shown no evil results. Instructed by his partial insuccess, Toussaint extended his method by injecting, not once, but on two successive occasions, the *supposed* devitalized anthrax blood, and he found that this increased the certainty of protection, and by late accounts he had at the veterinary school of Toulouse ten animals, sheep and dogs, which he had in this way rendered insusceptible to inoculation with the most virulent anthrax fluids. In carrying out his method, Toussaint found that not only was a repetition of the injection with the devitalized blood necessary, but that it was needful to allow a certain period (twelve to fifteen days) to elapse between the last injection and the inoculation with anthrax liquids; otherwise the protection was not attained. In short, it was with these injections of devitalized blood as it had been with the inoculations with virulent anthrax liquids practiced by Chauveau. If a new inoculation with virulent anthrax liquids were made while the system was still disordered with the results of the former operation, it only insured a severe or fatal result. To secure good results the febrile condition caused by the injection of the *supposed devitalized* anthrax liquid must have quite disappeared, and time must have been allowed for the elimination of the chemical products of the anthrax, and for producing the full obtainable impression on the living elements of the tissues, before the protecting influence could be relied upon.

A partial failure which befell Toussaint at Alfort deserves to be mentioned. Twenty sheep were injected with the *supposed devitalized* anthrax blood, and within four days four of them died of anthrax, their blood swarming with *bacilli*. Here, unquestionably, there was some lapse. Either the heat had not been sufficient to kill the bacteria in the anthrax liquid, and some active *bacilli* had been injected with the supposed harmless blood, or the anthrax germs had been introduced from some other source and produced the fatal results recorded. Properly viewed, the occurrence does not militate against Toussaint's method. It showed merely that he had employed too low a temperature or for too short a time in devitalizing the anthrax liquids, or that the experiment was so far vitiated by the accidental introduction of other anthrax germs. This will be evident when it is told that of the sixteen remaining sheep of the experimental lot a number have been inoculated with anthrax liquids, but all have resisted their evil influence.

The desideratum in Toussaint's method appears to be the exposure of the virulent liquid to be used for protective purposes to a higher temperature and for a longer time than he has practiced. If the protecting agent is a mere chemical product, as there is reason to believe, there is little danger of its destruction by exposure to 55° C. for a longer period, or even to a considerably higher temperature.

My results.—A pig was injected with one drachm of virulent swine-

plague blood which had been repeatedly heated to 130°, 150°, and 200° F., and a month later with an equal amount of virulent blood which had been raised to 130° F. for thirty minutes, and the day following for three hours. This caused some loss of appetite and appearance of ill health, but no very appreciable fever. Thirteen days after the last operation this pig was placed in a small pen with a pig suffering from swine plague, and at intervals of a month was twice inoculated with the virus of swine plague, but all without evil consequence.

Another pig was injected with a drachm of infusion of the mucus-covered fæces of a pig suffering from swine plague, the infusion having first been filtered and heated for one-half an hour to 130° F., until all movement of the contained bacteria had ceased. As in the other case there was some evidence of ill health, but no material fever, and on the thirty-eighth day the subject was placed in a small pen with a sick pig. Afterward, with intervals of a month, it was twice inoculated with virulent (swine plague) virus, but successfully resisted, and maintained good general health.

A third pig was injected with one drachm of pork infusion which had swarmed with bacteria, resulting from an inoculation with infusion of putrid maize. Before inoculating it on the pig the pork infusion was heated to 140° F. for three hours in succession. There resulted some derangement of health, slight fever, and a local swelling in the seat of injection. When these had subsided, on the fourteenth day, the pig was placed in a small pen in company with a diseased one. Nine days after she had a sharp attack of swine plague, which lasted eighteen days, and led to much loss of condition. Later, at intervals of one month, she was twice inoculated with active virus of swine plague, but on each occasion without any further ill result.

On the last occasion of the inoculation of these three pigs a fresh pig was inoculated with the same virulent matter, which caused considerable fever with a temperature varying from 104° to 106° F., but from which the subject finally recovered.

Here, then, we have two pigs protected from the noxious action of the swine-plague virus by being first brought under the influence of the chemical products resulting from the growth of this virus in the system. We have further a third pig treated in the same way with the products of an ordinary putrefaction fermentation in a pork infusion which had been similarly devitalized by heat, but this fails to secure the same immunity, and this pig suffers severely from swine plague when made to cohabit with a victim of that disease. Later, this pig and the two others successfully resist two successive inoculations with swine-plague virus, while a fourth pig inoculated with this same virus sustains a considerable but not a fatal attack.

The experiments, it is true, are limited in number and liable to the objection that the results may have been accidental coincidences, yet so far as they go they support the theory that the chemical product of the swine-plague germ when deprived of its living *microphytes* affects the system so as to render it, for the future, insusceptible to the attacks of such germs. When taken in connection with the fact that swine plague rarely recurs in the same individual, that, as in the case of other diseases that attack the same animal but once, the most rational explanation appears to be that it is the deleterious chemical products of the disease germ and not the germ itself that affects the system so as to secure this immunity, and finally that in the closely-allied disease of anthrax Toussaint has secured a similar insusceptibility by an identical process, it is altogether reasonable to suppose that we are here furnished with a

system of prevention which, if carried into general practice, would reduce our present losses from hog cholera to a comparatively insignificant figure.

It is not without hesitancy that I announce this conclusion, but this hesitation arises not so much from uncertainty as to the results as from the fear that if extensively resorted to it will be liable to be widely misapplied and to fall into unmerited discredit.

When it is considered that the term hog cholera is applied to every fatal disease of swine, it is at once seen how this method of preventing hog cholera would be applied to a large class of disorders to which it is in no sense adapted and would soon gain the most unqualified and most undeserved condemnation. One or two examples of the confounding of other affections with the genuine hog cholera may be quoted to illustrate this danger. In the report of the Department of Agriculture for 1877, Dr. Healey describes a so-called hog cholera which prevailed in Princess Anne county, Virginia, but which was due to minute worms embedded in the mucous coats of the stomach and bowels. From the cuts of some of these worms I would judge them to have been the embryos of the whipworms (*Tricocephalus dispar*). Long before Dr. Fletcher, of Indiana, found an epizootic of so-called hog cholera caused by the presence of the lard worm (*Stephanurus dentatus*) in great numbers in the liver. Mr. Hatch, chairman of the Congressional House Committee on Agriculture, recently told me that in his district a Dr. Johnson found the hog cholera (?) to be caused by worms in the lungs and bowels, and has virtually cleansed the district of this disease by the free use of tobacco. I have repeatedly seen a high mortality among pigs from the ravages of the large round worm (*Ascaris suilla*) which crowd the intestines and even block the gall ducts with the most serious and even fatal results. In other cases the presence in numbers of the small round-mouthed worm (*Sclerostonum dentatum*), or of the hook-headed worm (*Echinorynchus gigas*) gives rise to a similar widespread mortality, preceded by intestinal suffering and disorder and emaciation, which is readily mistaken for the genuine hog cholera.

Again, the presence in the bowels of myriads of *trichina spiralis*, and the irritation caused by them in boring through the walls of the intestines, may easily give rise to symptoms that may be taken for those of hog cholera. Now, nothing can be clearer than that our system of prevention applied to those verminous diseases would be utterly futile, and as all of them are spoken of as *hog cholera*, any general resort to the method would inevitably embrace such cases, and as surely bring condemnation on the measure.

Again, so-called hog cholera is sometimes found on investigation to be simple malignant or bacteridian anthrax, freely intercommunicable between different animals, and between these animals and man. In cases of this kind our method would probably protect against the anthrax, but we have as yet no evidence to show that the chemical products of anthrax would prove protective against the *genuine hog cholera*.

In other cases still we find a great mortality among hogs, and especially high-bred hogs, from *tuberculosis*. Here the disease usually attacks the bowels, and the attendant ulcers of their walls, and the enlargement of the mesenteric glands, with the consequent disorder of the digestive organs, abdominal pain, and emaciation, easily lead to the confounding of this disease with the sub-acute types of hog cholera. But there is no reason to suppose that the application of the suggested method of prevention to this disease would be of the slightest avail.

We might go on to enumerate nearly all the fatal diseases of swine,

but these examples will suffice to show how the method proposed is liable to the grossest abuse in ordinary hands. If fully confirmed by further experiment, and reduced to safety by all necessary precautions, it gives promise of proving a measure of the most beneficent kind, but if applied recklessly, and without due knowledge of the true nature of the existing disease, or due judgment as to method, it may prove far more hurtful than beneficial. From observations already made the following may be set down as among the necessary

PRECAUTIONS TO BE OBSERVED.

1st. See that it is the genuine hog cholera or swine plague that is being dealt with. This is equally necessary as to the disease to be prevented, and as to the virus which is to be devitalized for preventive inoculation.

2d. The virulent fluid to be devitalized may be the blood of a diseased animal, or the liquid exudation into a diseased organ, including the lumen of the bowel. In such cases it is best taken at the height of the disease rather than from a partially convalescent animal in which the virus may have disappeared, and the structural changes only may have been left. If from a cultivation in pork infusion, that should have been prepared with all due precaution against the introduction of air bacteria, and with access to air, but which air should not much exceed one-fifth of its bulk.

3d. In exposing this fluid to heat, that should be carried to 140° F. and retained at this temperature for an hour or more, until, in short, all indications of life in the contained mycrophytes has ceased.

4th. Swine to be operated on must be removed from all diseased hogs and infected places and objects, for with the presence of the living germ in the system the injection of the devitalized chemical products will only tend to aggravate the attack. For the same reason all inoculated animals showing symptoms of a severe attack and presumably suffering from bacteridian infection, in place of the simple intoxication with the chemical products, should be at once removed from the herd operated on.

5th. In inoculating the devitalized chemical products, the injection of a small quantity at a time and its repetition at intervals of three days or a week promises to be safer and more effectual than one large injection. The injection of 10 to 20 drops at a time and its repetition once or twice would probably secure a greater immunity with less loss of condition and progress than if a larger amount were introduced at once.

6th. The animals operated on should be carefully guarded against infection for three weeks after the last injection of the devitalized virus. The presence of the chemical poison in the blood and the attendant constitutional disturbance invites rather than debars the growth of the plague germ; hence the latter must be excluded until the former has been entirely eliminated. For the same reason the free use of disinfectants (chloride of lime, chloride of zinc, sulphate of iron, or carbolic acid) in the operating yards and buildings will be of the utmost value. So will every conceivable precaution against the introduction of disease germs through accidental channels, as by other animals, by the pork stolen by dogs, carried by men, &c.

ADVANTAGES PROMISED BY THIS METHOD.

1st. It offers immunity from a fatal disease by a method which does not entail the propagation of the living germ in the system of the animal to be protected.

2d. It avoids the risk of the preservation, amplification, diffusion, or increase of potency of the disease germ, all of which contingencies are possible in inoculations with a mitigated virus.

3d. It does away with the necessity for an exhaustive disinfection after the animals have been inocculated and have recovered from its results.

4th. The dose of the devitalized chemical products can be so graduated to the strength of the animal that there will be no risk of a fatal result. When even the mitigated living germ is introduced there can no longer be any certainty that it will not reproduce itself to a dangerous extent, or that owing to the special condition of the system or of its surroundings it may not suddenly assume its fatal type, but with the devitalized chemical products we can graduate the dose so as to secure as great a certainty in result as in the case of a dose of castor oil or Epsom salts.

5th. The system can be habituated to the poison and fortified against it by a succession of small doses, no one of which is at all dangerous in itself, whereas if a germ were once introduced, though of mitigated power, it may increase so as to develop a power that is altogether unexpected.

DISADVANTAGES AND DRAWBACKS.

These are few, apart from the certainty above noticed, that if largely resorted to it will be misapplied by many to other diseases than the genuine swine plague, and will thus fall into disrepute.

It can do no good but only harm to animals that are already infected, as it can only add to the deleterious products with which the germ is charging the system.

Its effect can only be evil if the subjects are allowed to become infected before the chemical products of the bacteria have had time to fully affect the system and to have become eliminated. If this is neglected, and early infection is allowed, it can only add to the mortality.

There is the additional disadvantage that to secure the protective products the production of the virulent germ must be kept up, either in the bodies of a successive series of diseased pigs or in an infusion of pork. The slightest carelessness with regard to the seclusion of these fields of poison, or as to the disposal of their products, may easily become the occasion of a spread of the worst type of the plague among unprotected animals.

On the whole these drawbacks can easily be guarded against, and it may well be hoped that in the hands of scientific men, who will not blunder at the outset as to the nature of the disease in hand, this method of protection may be availed of to reduce to the minimum our losses from hog cholera.

EXPERIMENTS IN INOCULATION WITH THE BLOOD OF A SUFFOCATED PIG.

In view of the observation of Signol that the blood of the portal vein of a suffocated horse was virulent when inoculated on other horses, and produced a disease that could be conveyed indefinitely from horse to horse, and the physiological fact that the hog demands an unusual amount of air in proportion to his size, I sought to resolve the question as to whether the swine plague could be produced by the modification of intestinal bacteria grown in the circulating blood, which had been largely deprived of air.

A four-weeks old Berkshire pig was taken from its dam and fed for two days on Indian corn meal and wheat bran. It was then killed by suffocation, and one hour later ten drops of blood from the *rete mirabile* of the small intestines were mixed with a drachm of river water and injected into the right flank of a four-months old Berkshire pig. This pig had on the fifth day a material rise of temperature, which continued for seven days, but there was no manifest dullness, loss of appetite, nor other very marked sign of illness. Three weeks after this pig was inoculated with the virulent intestinal contents of a sick pig, and again after six weeks more with virus cultivated in pork infusion with a limited supply of air, but suffered no marked impairment of health from either operation. It was also kept in an infected pen without any evil result.

A second four-months old Berkshire was inoculated with the portal blood of the suffocated pig—in this case ten hours after the death of the latter. The same amount of blood was used, having been mixed with half a drachm of water and thrown into the subcutaneous tissue of the left flank. In this pig also the temperature was elevated on the fifth day, and the high temperature lasted for five days, but as in the other case there was no serious evidence of ill health. As in the other case, this pig was twice thereafter inoculated with virulent matter without any evident harm.

I hardly dare to attach any importance to these results. The very slight impairment of health caused by inoculation with the blood of the suffocated pig, and the absence of all specific swine-plague lesions in the animals operated on, militates against the idea that they suffered from this disease. On the other hand, the fact that the second and third inoculations made with virulent matter had no apparent effect upon them, but that the last (February —) had a decided effect on a fresh and unprotected pig, might be held to imply that the first inoculation—that, namely, with the blood of the suffocated pig—had protected them against the inroads of the swine-plague poison. Such a protection would not be altogether unprecedented, as Pasteur found that his chickens inoculated with the mitigated virus of chicken cholera, were fortified not against that disease only, but against anthrax as well—a bacteridian affection, but one which seems to depend on an altogether different germ from that of chicken cholera. That the result thus obtained by Pasteur is not a principle capable of general application is shown by the result of my inoculation with the products of a fermentation in pork infusion inoculated from a fermenting infusion of maize, the pig thus inoculated having afterward had a sharp attack of swine plague when subjected to that infection.

We see that in certain cases the chemical products of the growth of one bacterium will affect an animal system so as to fortify it against the attacks of another bacterium, but also that this does not hold as between all the different bacteria fermentations, the products of one having no protective effect on the system against the attacks of certain others. It seems preferable, therefore, to leave the bare facts stated as they have been observed. They may serve as a suggestion for further experiment in this direction until the present indications shall have been otherwise explained, or, if they really bear out the theory I set out to test, until the protective action shall have been placed on a solid foundation.

Respectfully submitted.

JAMES LAW.

ITHACA, N. Y., *March* 14, 1881.

RECORD OF DR. LAW'S LATER EXPERIMENTS.

SMALL WHITE PIG NO. 11.

	Temperature.		Remarks.
	Morning.	Evening.	
1880.	°	°	
Oct. 11	....	....	Inoculated by injecting one drachm of the blood of No. 9, which had been first heated to 130°, 150°, and 200° F., on successive occasions, and two drops of carbolic acid added.
12	....	102	
13	102	103	
14	102	102.5	
15	102.5	102.5	
16	101.5	101.5	
17	101.5	102	
18	102	103	
19	101.5	102	
20	101	101.5	
21	101.5	103.75	
22	102	103	
23	101.5	102.5	
24	102.5	102.75	
25	102	103	
26	103.5	102.5	
27	101	101.5	
28	101.25	101.5	
29	101.5	102	
30	102	103	
31	102	102.75	
Nov. 1	102.75	103	
2	102	102.75	
3	102	102	
4	102	102.5	
5	101.5	102	
6	101.5	102.75	
7	101.5	102	
8	101	101.5	
9	101	101.5	
10	100.5	101	
11	100	101	
12	100.5	101	
13	101	102	
14	101.5	102.5	
15	100	101	
16	100	100	
17	100	102	
18	100	101.25	
19	101.25	102	
20	100	100	Injected one drachm blood serum from No. 8. Blood has stood as a firm clot since November 11, and was heated to 130° F., for thirty minutes, November 19, and again for three hours November 20.
21	100	101	
22	100	101.5	
23	101	101.75	No local swelling where injected.
24	102	103	
25	101	102	
26	101	101	
27	101	102	
28	101.5	102	
29	101	101.5	Keeps lively, well, and fat.
30	101	101.75	
Dec. 1	102	102	
2	101	102	
3	101.5	102	Placed in small pen with sick pig No. 13.

	Temperature.		Remarks.
	Morning.	Evening.	
1880.	°	°	
Dec. 4	102.75	103.5	
5	102	102.75	
6	101.2	101	
7	102	103	
8	101.75	102.5	
9	101.75	102.75	
10	101.5	102	
11	101.75	102	
12	101.75	102.5	
13	102	102.5	
14	103.5	100	
15	102	102.5	
16	102	102.25	
17	102	102.5	
18	102	102	
19	100	101	
20	101	101.75	
21	101.5	103.5	
22	101.5	102.75	
23	102.25	101	
24	100	102	
25	100.75	102.25	
26	101	102.5	
27	100.75	102	
28	101	102.25	
29	100.5	101.5	
30	100	101	
31	100	101	
1881.			
Jan. 1	100	101	
2	100.5	102	
3	101	102.25	
4	102	102.25	Inoculated in tail with virulent matter from intestine of sick pig sent from Michigan, in a quill with ends waxed.
5	101	101.5	
6	100	101	Off feed; gets thin.
7	101	101.5	Do.
8	100	100	Feeds well.
9	100	100	
10	100	100	
11	100	100.2	
12	100	100.2	
13	100	100	
14	100	100.25	
15	100	100.5	
16	100	101	
17	100	101	
18	100	100.5	
19	100.5	101	
20	100	100.5	
21	100.2	101	
22	100.2	100	
23	100	101.5	
24	100.5	101	
25	100	101	
26	100.5	100.2	
27	100.2	101	
28	101	....	
29	101	....	
30	101	....	
31	101	....	
Feb. 1	100.5	....	
2	100.75	....	
3	100.5	....	
4	100.25	....	
5	101	....	
6	100.5	....	

RECORD OF DR. LAW'S LATER EXPERIMENTS—Continued.

SMALL WHITE PIG NO. 11—Continued.

	Temperature.		Remarks.
	Morning.	Evening.	
1881.	°	°	
Feb. 7	100.25	....	
8	100.5	....	
9	100.25	....	
10	100	....	
11	101	....	
12	101	....	
13	101.5	....	

	Temperature.		Remarks.
	Morning.	Evening.	
1881.	°	°	
Feb. 14	....	....	Inoculated with pork infusion inoculated with virus sent from Michigan, and cultivated with a very limited amount of air.

From this time up to March 9 the temperature varied from 101° to 103°; the appetite remained excellent and the subject gained rapidly in condition.

SMALL WHITE PIG NO. 12.

	Body temperature.		Remarks.
	Morning.	Evening.	
1880.	°	°	
Oct. 18	....	103	
19	102	103	
20	102.5	103	
21	102.75	103.75	
22	102	102.75	
23	101	102.5	
24	101.75	102.5	
25	101.75	102.75	
26	102.75	103	
27	103	103.25	
28	100	100.5	
29	101	103.25	Injected hypodermically one drachm of infusion of hard mucous feces from sick pig No. 8, having first filtered the liquid and heated to 131° F. for thirty minutes.
30	102	103.5	
31	101.75	102	
Nov. 1	101.5	102	
2	102	102.75	
3	101.5	102	
4	101.5	102	
5	102	102.5	
6	103	103.25	
7	102	103	
8	101.5	102	
9	101.5	101.75	
10	101	101.5	
11	101	101.75	
12	101.5	101.75	
13	101.5	102	
14	101.5	102	
15	100	101	
16	100.5	101	
17	101	102	
18	101.5	102.5	
19	102.25	102.5	
20	100	100	
21	100	101	
22	102	103	
23	103	104	Appears in rut.
24	102	103	
25	100	100	

	Body temperature.		Remarks.
	Morning.	Evening.	
1880.	°	°	
Nov. 26	103	104	
27	103	103	
28	102.75	103	
29	102	102	
30	102	103	
Dec. 1	102	103	
2	101	103	
3	103.5	104	
4	104.25	103.75	Placed in pen with sick pig No. 13.
5	103.5	104.5	
6	103	103	
7	102.5	102.75	
8	102.25	102.75	
9	102.5	102.75	
10	102	102.75	
11	102	102.75	
12	102.25	103	
13	102.5	103.5	
14	103.25	102.5	
15	102.5	103	
16	103	102	
17	102.5	102.75	
18	102.5	103	
19	102.5	103	
20	102.5	103.25	
21	102.5	103	
22	102	103	
23	100	102.5	
24	102	102.5	
25	102	102.75	
26	102	102.5	
27	102.25	103	
28	101.75	103	
29	102.5	103	
30	100	100.5	
31	100	100.5	
1881.			
Jan. 1	101	102	
2	101.5	102.5	
3	102	103	
4	102.5	103	Inoculated with matter from intestine of diseased pig, sent from Michigan in quill with ends waxed.

SMALL WHITE PIG NO. 12—Continued.

	Body temperature.		Remarks.
	Morning.	Evening.	
1881.	°	°	
Jan. 5	102	102.5	
6	102	102	
7	102	102.5	
8	102.5	102.5	
9	101	102	
10	101	102.25	
11	....	102.25	
12	....	102	
13	....	102	
14	....	102.25	
15	....	102	
16	....	102.5	
17	....	102	
18	....	102.25	
19	....	102	
20	....	102	
21	....	102.25	
22	....	102	
23	....	102.25	
24	....	102	
25	....	101.5	
26	....	101.75	
27	....	102	
28	....	102	
29	....	102.2	
30	....	101.75	
1881.	°	°	
Jan. 31	....	102	
Feb. 1	....	102	
2	....	102.25	
3	....	102.5	
4	....	102	
5	....	102	
6	....	102.25	
7	....	102	
8	....	101.75	
9	....	101.5	
10	....	102	
11	....	102	
12	101.75	101.75	
13	....	102	
14	....	....	Inoculated with pork infusion which had been inoculated with infecting matter from sick pig. From this time up to March 9 it maintained the same average temperature as above, and fed well and improved in condition.

SMALL WHITE PIG, NO. 13.

	Body temperature.		Remarks.
	Morning.	Evening.	
1880.	°	°	
Oct. 18	....	102	
19	102	103	
20	100	101.5	
21	102	103.75	
22	102	103	Inoculated with one drachm pork infusion, filled with bacteria, from having been infected from infusion of putrid maize. Infusion heated to 140° for 45 minutes before it was inoculated.
23	102	102.5	
24	101	102	Slight swelling in the seat of inoculation.
25	102	103	
26	103.5	103.5	Swelling has disappeared.
27	101	101.5	
28	101.5	102.5	
29	102	103	
30	102.5	103	
31	100	101	
Nov. 1	100.25	101.5	
2	101	102.5	
3	101.5	103	
4	102	103	Placed in pen with sick pig No. 10. Present Report.
5	102.5	103.5	
6	102.5	102.75	
7	102.5	103	
1880.	°	°	
Nov. 8	102	102.75	
9	102.5	103	
10	103	103.5	
11	102.5	103.5	
12	102	103.25	
13	103	103.5	
14	103.25	104	
15	103	103.5	Feeds poorly; black unctuous exudation on skin.
16	103.5	104	
17	103	104	
18	103.5	103.75	
19	103	103.25	An inch of the margin of each ear blue.
20	103	103	
21	103	103	
22	102	103	
23	102	102	
24	99	99	
25	100	102	
26	101	102	
27	102	102.5	More lively. Feces still fetid.
28	102.5	103.5	
29	103.75	105	
30	102	102	
Dec. 1	102	102	
2	102.5	104	
3	105	105	
4	103.5	102	
5	102.5	103	Thaw with rain.

SMALL WHITE PIG No. 13—Continued.

	Body temperature.		Remarks.
	Morning.	Evening.	
1880.	°	°	
Dec. 6	102.75	103.5	Freezing.
7	102.5	103	Cold.
8	102.75	103.25	Do.
9	102.5	103	Very cold.
10	102.75	103.25	Below zero. Appetite gains.
11	101.75	102.75	Very cold.
12	101	102	Thaw—rain.
13	101.5	102.75	Do.
14	103	103	Mild.
15	103	103.25	Freezing.
16	103	103.25	
17	102.75	103.25	
18	99	101	Cold intense. Appetite good.
19	100	102.5	Cold intense.
20	101.75	102.25	
21	102	102.75	
22	102	102.5	
23	100.5	102.75	
24	102.5	103	
25	102	103	
26	102.25	103	
27	102.5	103.25	
28	102.5	103.5	
29	103.5	103.5	
30	100	102	Temperature 14°.
31	100	102.75	Still below zero.
1881.			
Jan. 1	102.75	104	
2	103	103.5	Mild.
3	102	103	
1881.	°	°	
Jan. 4	102	103	Inoculated with infecting bowel products from Michigan, sent in a sealed quill; $\frac{1}{16}$ grains used.
5	102	102.5	
6	102	102	
7	102	102.5	Thriving.
8	102	102.5	
9	101.5	102	Raw—cold.
10	101	103	Snow-storm.
11	103	....	
12	102.5	....	
13	102.75	....	
14	102.25	....	
15	102	....	
16	102.25	....	
17	102	....	
18	102	....	
19	102	....	
20	102.25	....	
21	102.25	....	
22	102	....	
23	102	....	
24	102	....	
25	102.25	....	
26	102.5	....	
27	102	....	
28	102	....	
29	102.25	....	
30	102.25	....	
31	102	....	

From this time the health continued excellent, though the subject was again inoculated February 14 with virus cultivated in pork infusion with a limited amount of air.

SMALL MALE BERKSHIRE PIG, No. 14.

This subject I acquired a fortnight after I had, by your instructions, suspended work for the Department of Agriculture, but as it was employed as a test case it is important to my conclusions that it should be introduced into this report.

February 14, 1881, it was inoculated with virus that had been cultivated in pork infusion with a very limited supply of air (the same virus used on Nos. 11, 12, 13, 15, and 16). The result was a very material rise of temperature which stood at 104° F. February 18, 105.25° February 21, and 106° for nearly a week thereafter. The appetite fell off somewhat, the inguinal glands were enlarged, the skin became scurfy and slightly unctuous, and he fell off slightly in condition.

The attack terminated in recovery, but was very valuable as showing the marked effect on an unprotected system of the poison which proved utterly harmless to the four protected pigs mentioned above.

Female Berkshire Pig, four months old, No. 15.

	Temperature of body.		Remarks.
	Morning.	Evening.	
1880.	°	°	
Dec. 11	103	103.5	
12	103	103.75	
13	103	103.5	Injected into the left flank ten drops of the blood of the portal vein of a pig suffocated one hour before. The injected blood was diluted in one drachm of water.
14	104.5	104.5	
15	103.5	103.5	
16	103.5	103.75	Cold.
17	103.5	104	Very cold.
18	104	104.5	
19	104.5	105.5	
20	104.5	105	
21	104	104.5	
22	104	104.5	
23	103.25	103.25	
24	102.5	103.5	
25	103	105.5	
26	104	105	
27	103.75	105	
28	103.5	104.5	
29	103.5	103.75	
30	103	103.5	Temperature, 14°.
31	102	103.5	Still below zero.
1881.			
Jan. 1	102	103	
2	102	103.5	
3	102.5	104	
4	103.5	104	Inoculated with virulent intestinal contents sent from Michigan in a sealed quill.
1881.	°	°	
Jan. 5	103	103.5	
6	103.5	104	Slightly off feed.
7	103.5	104	
8	103.5	103.5	
9	102.75	102.75	
10	102.75	103.25	
11	103.25	....	
12	103	....	
13	103.25	....	
14	103.5	....	
15	103.5	....	
16	103.25	....	
17	103.5	....	
18	103	....	
19	103	....	
20	103.25	....	
21	103.5	....	
22	103.25	....	
23	103.25	....	
24	103.25	....	
25	103.5	....	
26	103	....	
27	102.75	....	
28	102.75	....	
29	102.5	....	
30	102.75	....	
31	102.75	....	

February 14, this pig was inoculated with virulent pork infusion cultivated with a very limited supply of air, but alike before and after the inoculation the temperature maintained about the average of the last few weeks above recorded.

Female Berkshire Pig, four months old, No. 16.

	Body temperature.		Remarks.
	Morning.	Evening.	
1880.	°	°	
Dec. 11	103	103.5	
12	103	103.75	
13	103.5	103.75	Inoculated with blood of the portal vein of a pig suffocated ten hours ago. About ten drops of blood were mixed with one-half drachm of water and injected.
14	104.5	104	
15	103	103.25	
16	103.25	103.5	
17	103	103.5	
18	103	104.5	Very cold.
19	104	105	Do.
20	104	105	Calm.
21	104.5	105	
22	104.25	104.75	
23	104	103	
1880.	°	°	
Dec. 24	103	103.5	
25	103.75	105	
26	104	105	
27	103.75	104.75	
28	103.75	105	
29	104.5	105	
30	104	104	Temperature 14°.
31	103.5	104	Still below zero.
1881.			
Jan. 1	102	102.5	
2	103	104	
3	103.5	104.5	
4	104.5	104.5	
5	104	104	
6	103.75	104	Inoculated with infecting contents of bowel sent from Michigan in a sealed quill.

FEMALE BERKSHIRE PIG, FOUR MONTHS OLD, No. 16—Continued.

	Body temperature.		Remarks.		Body temperature.		Remarks.
	Morning.	Evening.			Morning.	Evening.	
1881.	°	°		1881.	°	°	
Jan. 7	103.5	104		Jan. 15	103	....	
8	103.5	103.5		16	103.25	....	
9	103.5	103.5		17	103.75	....	
10	103	103.25		18	103.25	....	
11	103.5	....		19	103.5	....	
12	103.25	....		20	103.5	....	
13	103.25	....		21	103.75	....	
14	103.25	....		22	103.5	....	
				23	103.25	....	
				24	103.25	....	
				25	103.25	....	
				26	103.5	....	
				27	103.25	....	
				28	103	....	
				29	103.25	....	
				30	103	....	
				31	103	....	

February 14, this pig was again inoculated with a cultivation of swine-plague virus in pork infusion with a limited amount of air, but the health continued unaffected, and the temperature as in the last few weeks recorded above.

INVESTIGATION OF SWINE-PLAGUE.

THIRD REPORT OF DR. H. J. DETMERS.

Hon. WILLIAM G. LE DUC,
Commissioner of Agriculture:

SIR: In presenting to you the present report and the results of my investigation of swine-plague from April, 1880, till date, permit me to make a few remarks, by way of preface, before I enter into my subject. In my previous investigations, commencing in August, 1878, and continuing with some interruptions till March, 1880, I endeavored first to ascertain the nature and the cause or causes of the disease, the means and manner of its spreading, and the working of its morbid process; and, secondly, to discover the means necessary to check its spreading and to prevent its outbreak. In my present investigation, which may be considered as a continuation of my former work, I made it a special object, first, to verify the results of my former experiments; secondly, to learn the most practical means of prevention, that is, such as would most likely be the least objectionable to the farmer, and prove both effective and easy of application; thirdly, to ascertain whether and to what extent an attack of swine-plague terminating in recovery is able to destroy further predisposition or to produce immunity from the effect of a subsequent infection; fourthly, to study as much as possible the nature, characteristic properties, or features and workings of those schizomycetes (Naegeli) or schizophytæ (micrococci and bacteria) which constitute the infectious principle and the cause of swine-plague; and, fifthly, to ascertain, if possible, the influences or causes which made the disease more lenient or less malignant in 1879 and 1880 than in 1878; in other words, to discover the agencies or conditions which cause the disease to be more lenient in its single attacks, and in its epizootic spreading in one season and in one locality than in another. Whether and how far I have succeeded in solving these problems is not for me to say.

The following pages will show what has been accomplished, and what yet remains to be done. That more might have been done, if circumstances had been favorable, I admit. When I commenced my first investigation, in the fall of 1878 and in the winter of 1878–'79, I had clear sailing, because an abundance of material was always available. The disease presented itself almost everywhere, in its most malignant form. This last year it was not so; material, that is, material from a malignant case, was often wanting when needed, and usually had to be obtained from a great distance. Sporadic outbreaks of swine-plague were numerous enough, but the cases, being invariably very mild, could not be relied upon to furnish material for experimentation, because it was found, this season as well as last year, that an inoculation with

infectious material from a very mild case produces, as a rule, only a mild attack. Hence, as it was my intention to find reliable means of prevention, and to subject the preventives used last year to a severe test, it was not advisable to inoculate from any case of swine-plague that presented itself or was convenient. I had to make my selections, and very often was obliged to travel a considerable distance to obtain suitable inoculation-matter from a really malignant and typical case of swine-plague. Whenever it was possible to get material from a malignant and typical case, any other was rejected; and so some time was lost in finding malignant cases; but the results of my experiments have gained in reliability. I preferred to lose some time rather than to make experiments which cannot be relied upon and are apt to mislead or to conceal the truth which we endeavor to ascertain. I have also been very careful never to use any material for purposes of inoculation that was tainted with putrefaction, and, consequently, am sure that I have never mistaken septicæmia or pyæmia for swine-plague; neither do I consider any morbid changes as those of genuine swine-plague, unless the peculiar changes (hepatization) in the lungs, characteristic of that disease, are fully and unmistakably developed. For purposes of inoculation I have always chosen material, whenever I had a choice, from animals in which not only the lungs, but also the intestines, the cæcum and colon, or one of them, exhibited in a fully-developed form the characteristic morbid changes—the lungs the peculiar hepatization, and the cæcum and colon the ulcerous tumors. Further, I never used material except from animals of which I myself made the post-mortem examination, and, whenever obtainable, took it from pigs killed by bleeding while in an advanced stage of swine-plague. Whenever such an animal was not available, and I was therefore obliged to take the material from a dead pig, it was always taken from one that had been dead but a very short time—an hour or two—and in which putrefaction was not noticeable. Further, no material was used for inoculation that had not been subjected to a thorough microscopical examination, and found free from bacterium termo at the time the inoculation was made. So I am confident that no mistake, confounding the morbid changes of septicæmia or of other diseases with those of swine-plague, has occurred.

As this report is to be considered as a continuation, or rather completion, of my former reports, published in your Special Report No. 12, in your Annual Report for 1878, in your Special Report No. 22, and in your Annual Report for 1879, it will be best, in order to avoid as much as possible unnecessary repetitions, to adopt the same headings, and to arrange the material on hand in the same order as in the previous reports.

1. Definition of swine-plague.

But little needs to be added under this head to what has been previously said. The following will suffice:

Swine-plague, though a disease peculiar to swine, can, under favorable circumstances, be communicated to other mammals, and under very favorable circumstances probably also to human beings, but very likely not to barnyard fowls. It can and may attack one and the same animal twice, and even three times, but if it does, the second and third attacks are always mild ones and not apt to become fatal unless complicated with other diseases. As a rule, however, the first attack, provided the animal recovers, produces immunity from the effect of a subsequent infection, at any rate for some time and it may be for life. The same

seems to destroy fully or partially the conditions necessary to the development of the swine-plague schizophytæ or schizomycetes. Even an interrupted attack, or, in other words, an infection that has been prevented from causing serious morbid changes, either by medical treatment or otherwise, as a rule, seems to produce immunity from the effect of a subsequent infection, the same as a fully developed attack. Further, wherever the morbid process of swine-plague has become sufficiently developed to produce morbid changes, serious enough to manifest their existence by a rapid emaciation, but particularly a permanent enlargement of the mesenteric lymphatic glands, and of other lymphatic glands in general, the animal, if surviving, may regain its appetite and consume as much food as any healthy hog of the same age, but will never show adequate growth and thrift, and will be a source of loss to its owner as long as it lives. Growth and thrift, it seems, remain more or less unimpaired only in such cases in which the morbid process does not sufficiently develop to produce permanent morbid changes in the lymphatic system, or more particularly, permanent swelling and obstruction in the lymphatic glands.

Although the morbid process of swine plague can have its seat in almost any organ or part of the body, it must be considered as characteristic of the disease that the lungs invariably are more or less affected, and constitute in a large number of cases the principal seat of the morbid process. At any rate, in over two hundred post-mortem examinations I found, in every case, more or less of that peculiar hepatization characterized by its distinct limits, by its different appearance and color, according to its age, in different parts of the lungs, and sometimes even in adjoining lobules, and by the small red, or red-brown specks of extravasated blood, usually exceedingly numerous in those parts of the lungs not yet fully hepatized, or in the first stage of hepatization. So I have come to the conclusion that hepatization of at least some portion of the lung-tissue must be considered as a never absent morbid change, characteristic of the disease, and that no swine-plague is existing where the lungs are not morbidly affected, or where they are found to be in a normal condition. If other parts were not also frequently affected, and in some cases even more than the lungs, swine plague might be called a "bacteritic" pneumonia.

2. Symptoms.

The disease, on a whole, was this year of a much milder type and less complicated than in 1878 and in the early part of 1879, and the symptoms, therefore, were less varied, but otherwise exactly the same as those given in my first report, and so nothing needs to be added. Moreover, the symptoms of swine plague are sufficiently known to most farmers to enable them to recognize the disease when it makes its appearance. Great dumpishness and total indifference to surroundings, observed this year in some cases, proved to be the effect of serious morbid changes in the liver, caused, however, more by the presence of numerous entozoa in the hepatic ducts than by the morbid process of swine-plague.

3. Prognosis.

In my last report I said, in regard to prognosis, that the same, though always unfavorable, is, as a rule, not quite so hopeless in the winter and spring as in the summer and early autumn, probably because in the former seasons the seat of the morbid process is limited more frequently to the respiratory organs and to the pulmonary tissue, and is not found

so often in the intestines. Still this difference, partially due, no doubt, to some other causes and conditions to be explained below, is not a very great one, especially if it is taken into consideration that swine plague is always more fatal to very young pigs than to older animals or full-grown hogs, and that more pigs are born in the spring than at any other season of the year.

The above observation concerning the prognosis, although undoubtedly correct, needs a slight modification. The death rate in a herd of swine affected with swine-plague is also increased or decreased respectively by the comparative malignancy or leniency of the epizooty, which, it seems, depends largely, on the one hand, upon the rapidity with which the swine-plague schizophytæ change, develop, and propagate, and, on the other hand, upon the size of the herd, the condition of the premises on which they are kept, the number of diseased animals in the herd, and the mode and manner in which the animals are attended to. Everything else being equal, the mortality, as a rule, will be the greater the more rapidly the disease is spreading from one animal to another, and the more abundant the infectious principle, the swine-plague schizophytæ. This is easily explained. The larger the herd and the greater the number of animals diseased at the same time, the greater is also the quantity of the excretions containing the swine-plague schizomycetes or schizophytæ, consequently the more abundant the means of infection, and the more rapid the spreading of the disease within the herd. Again, a rapid spreading causes many animals to become affected at the same time and thus increases not only the sum total of the number of schizophytæ discharged with the excretions of the diseased animals, but also the quantity of the infectious principle taken up by each individual pig. As a consequence the single attacks become the more malignant and the more fatal the more rapidly the disease is spreading; and *vice versa*, the more malignant the single cases the more rapid will be the dissemination of the infectious principle and the spreading of the disease. That such is the case becomes yet more apparent if it is taken into consideration that ulcerous tumors in the cæccum and colon are, according to experience, a more frequent occurrence—are found in about 90 per cent. of all cases if the epizooty is malignant and occurs less frequently—are found only in about 40 or 25 per cent. of all cases if swine-plague presents itself in a comparatively mild form; and that wherever ulcerous tumors are existing much more infectious material (schizophytæ) is discharged with the excrements than in cases in which ulcerous tumors are wanting, or in which the intestinal canal is not seriously affected.

MORBID CHANGES.

On the whole the morbid changes found at the *post-mortem* examinations in 1880 do not essentially differ from those observed in 1878 and 1879. Qualitatively they are exactly the same. In the fall of 1878, and in the winter of 1878-'79, swine plague presented itself in a very malignant form almost everywhere where it made its appearance, and besides the never-absent morbid changes in the lungs, consisting in a peculiar hepatization of a larger or smaller portion of the pulmonary tissue, and in a deposit of fluid exudation and numerous small extravasations of blood in the non-hepatized parts of the lungs, other important and characteristic morbid changes, especially in the cæcum and colon, and presenting themselves as ulcerous tumors, projecting like knobs or buttons over the surface of the mucous membrane, were found in about 90

per cent. of all cases examined. In the winter of 1879-'80 the disease on a whole, was much milder, and those ulcerous tumors presented themselves in about 50 per cent. of the cases examined, while in the spring, summer, and fall of 1880 the disease prevailed in a still more lenient form, and the morbid changes in the cæcum and colon, the ulcerous tumors, were not found in more than 25 or 30 per cent. of the cases examined. The morbid changes in the lungs, however, proved to be exactly the same in 1880 as in 1878, at any rate presented in both years the same pathological features.

Entozoa, such as *Strongylus paradoxus* in the bronchial tubes, *Ascaris lumbricoides* in the stomach and duodenum, and *Trichocephalus crenatus* in the cæcum, but especially the two former, have been found in quite a number of cases, but it will hardly be necessary to say once more that these worms do not constitute the cause of swine plague, and that their presence is merely an accidental complication, well calculated, though, to increase the malignancy of the morbid process, because their presence necessarily weakens the constitution of the animal, and thus facilitates the operations of the schizophytæ. On the other hand, worms always thrive better in a diseased or declining organism than in a healthy animal. The two last-named entozoa have been found in several cases, in which their presence was not attended with any conspicuous morbid changes in those parts—stomach and intestines—in which the worms were found. The same, of course, cannot be said of *Strongylus paradoxus* in the bronchial tubes, because in every case of swine plague the lungs are more or less diseased, and it is exceedingly difficult to determine how much or how little the presence of those worms may have contributed in bringing about those changes. In parts of the lungs but little affected by the morbid process of swine plague, but infected with lung-worms (*Strongylus paradoxus*) the mucous membrane of the bronchial tubes presented a little swelling or what may be called a catarrhal condition.

In my last report I advanced reasons for the less frequent occurrence of the ulcerous tumors in the large intestines in the summer and fall of 1879 and in the winter of 1879-'80 than in the fall of 1878. The same undoubtedly are well founded, and have contributed in bringing about the above result, but I find that the causes assigned are not the only ones. The occurrence of those ulcerous tumors is the more frequent the more virulent the morbid process, and the comparative malignancy or leniency of the latter depends largely upon the rapidity or slowness respectively with which the schizophytæ propagate and undergo transformation, as will be more fully explained under another heading.

Professor Dr. Roloff, director of the Royal Veterinary School at Berlin, states in a private letter of recent date that ulcerous tumors in the cæcum and colon are not found at the *post-mortem* examinations of pigs affected with swine plague (*Schweine-Seuche*) in Germany, and hints at the possibility of those ulcerous tumors being foreign to the morbid process of swine plague, and previously existing complications, or morbid changes of longer standing than those produced by the morbid process of swine plague. That such is not the case—that, on the contrary, those ulcerous tumors, though not present in every case, constitute one of the most characteristic morbid changes of swine plague, and are the product of the morbid process of that disease, is proved beyond a doubt, 1, by the frequency of their occurrence in such experimental pigs as were perfectly free from any scrofulous or tuberculous affection, and in every respect in good health when inoculated with swine-plague material. If those ulcerous tumors were previously existing complica-

tions they would not have been met with in any of my experimental pigs, because I have been very careful and very particular, especially in 1878–'79, when ulcerous tumors were more frequently met with than in 1880, in selecting none but perfectly healthy animals for experimental purposes, unless experimental pigs Nos. 3, 4, 5, 6, and 7, bought this year of Mr. Lawrence, are exceptions. They were, as is stated below, coughing some when I received them, because they had lung-worms, but were otherwise healthy and perfectly free from any scrofulous or tuberculous affection. But neither No. 4 nor No. 5, the only ones of that lot which died of swine-plague, had any ulcerous tumors in the cæcum or colon (*cf.* account of *post-mortem* examination below). 2, by the fact that the morbid process of swine plague, wherever it causes sloughing or ulceration on the external surface of the body, for instance, in the eyelids, in the noses of pigs that have been ringed, in the lips and faces of small suckling pigs that have been fighting for a teat, in the scrotum of pigs recently castrated, and in any other sore or wound that may happen to exist, produces almost precisely the same morbid changes—a proliferous growth of morbid cells and granular detritus—as in the ulcerous tumors in the cæcum and colon.

In other respects, no essential differences have been observed. The disease of 1880 is exactly the same swine-plague that prevailed in 1878–'79; it is only less malignant, and spreads with less rapidity. A rapid spreading and a frequent occurrence of ulcerous tumors go together, because the schizophytæ, which are voided with the excrements, are, for reasons explained before, better calculated to spread the disease from animal to animal and from herd to herd, than those discharged by, or emanating from, the body of a diseased hog in any other way or manner; and the more developed the morbid process in the intestinal canal, the greater the number of swine-plague schizophytæ discharged with the excrements. As said before, the disease in all other respects proved to be exactly the same as in 1878–'79, and presented essentially the same features in different localities. A comparison of the morbid changes found at the *post-mortem* examinations, made at different places, will show that such is the case. In order to avoid too much repetition, I shall only give an account of about a dozen *post-mortem* examinations which, covering the whole time from April till date, in the central, eastern, southern, and western parts of the State of Illinois, will probably suffice. It may be remarked here that in the following accounts all such parts and organs as did not present any visible morbid changes are, as a rule, not mentioned. So, for instance, where no external morbid changes, such as redness of the skin, petechia, &c., were found, nothing is said about external appearances. Wherever entozoa (worms) were present it will be mentioned.

POST-MORTEM EXAMINATIONS.

1. *Mr. Dillon's pig No.* 1.—Autopsy in forenoon of April 6. The pig, about five or six weeks old, had died in the morning. Lymphatic glands diseased and swelled; lungs but slightly affected; morbid changes (hepatization) restricted to lower parts of anterior lobes; numerous ulcerous tumors in cæcum and colon.

2. *Mr. Dillon's pig No.* 2 (*belonging to the same litter as No.* 1).—It had died during the night. Autopsy in the forenoon of April 6. Lymphatic glands enlarged; about one-half of the whole lung-tissue degenerated; red, brown, and gray hepatization; considerable serum in the pericardium, and auricles of heart congested, that is, the smaller blood-

vessels and capillaries turgid with dark-colored blood. No ulcerous tumors.

3. *Dillon's pig No.* 3.—Of the same age as Nos. 1 and 2, in a dying condition, and killed by bleeding in forenoon of April 9. Autopsy two hours later. Morbid changes: eyelids swelled and eyes almost closed; more than half of the substance of the lungs hepatized; all lymphatic glands, but particularly those situated in the large cavities of the body, enlarged; some serum in the pericardium, and a small portion of the liver congested; no other morbid changes.

4. *Experimental pig No. 4—a black boar pig, about six months old.*—It was inoculated with material lung exudation from Dillon's pig No. 2, on April 7, showed first symptoms of disease on April 10, and died on the night of April 23–24. Autopsy at 8 a. m. of April 24. Morbid changes: eyes closed and eyelids ulcerating; nose—the pig had been ringed before I bought it—swelled, sore, and ulcerating; skin on scrotum and between the legs reddish-purple. Internally, all lymphatic glands enlarged; the lungs very extensively degenerated; the left lobe about half hepatized, and the non-hepatized parts, that is those in which the normal structure was yet preserved, containing innumerable small extravasations of blood, and a large quantity of recent and yet fluid exudation; in the middle of the external surface of the lobe a portion of the pleura, of the size of a silver dollar, adhering to the costal pleura, and the pulmonary tissue beneath very hard and solid. The right lobe of the lungs almost entirely hepatized, very solid, of an almost uniform brown color, and adhering nearly with its whole external surface (lung-pleura) to the costal pleura or to the wall of the chest. Both lobes appeared very much enlarged and completely occupied the whole space in the chest, pressing even the diaphragm backward. The bronchial tubes contained some lung-worms (*Strongylus paradoxus*). About three or four drams of serum in the pericardium; the heart very large, and its blood vessels and capillaries, not only in the walls of the auricles but also in the walls of the ventricles, gorged with dark-colored blood. The blood in the veins and in some arteries coagulated of a brownish or carbonized red color, but was apparently very much diminished in quantity. In the abdominal cavity, the spleen slightly enlarged; all mesenteric glands very large, and the blood vessels of the mesenterium turgid with dark-colored blood. No developed ulcerous tumors in large intestines, but the mucous membrane of the cæcum swelled, and of a granular appearance. (As to the morbid changes in the lungs *cf.* microphotograph, Plate 1.)

5. *Experimental pig No.* 5.—This animal was about six months old, and was inoculated with lung-exudation of Dillon's pig No. 1 on April 7, was taken sick on April 11, and died late in the evening of April 30. The autopsy was made early in the morning of May 1. Morbid changes: Externally, the skin on snout, between fore legs under the abdomen, and between hind legs, purplish red. Internally, the blood vessels (veins) almost destitute of blood, and the little blood that was found of a very dark (carbonized) color, till it had been exposed to the air for some time. The larger veins (vena cava, posterior and anterior) contained firm and solid white-yellowish strands of coagulated fibrine. All lymphatic glands very much enlarged. The lungs, which entirely filled the space of the thoracic cavity, very extensively degenerated. In the left lobe hepatization most developed in the anterior and lower portions, and extending to about half of the whole pulmonary tissue. In the center of the hepatized parts some whitish or straw-colored (about the color of old cheese) consolidation presenting the appearance of a dense

and hard fibrous tissue. The non-hepatized portions of the left lobe œdemic, and containing a large quantity of fluid exudation. The hepatized portions everywhere distinctly limited. Adhesion between lung-pleura and costal pleura at several places. In the right lobe of the lungs still more extensive hepatization, extending to about three-fourths of the whole tissue. The lung-pleura also at several places adhering to the costal pleura, and the union firm enough to require a knife to effect a separation. In the hepatized portions several straw-colored or dirty white-yellowish spots caused by incipient detritus. The non-hepatized portions of the lung-tissue œdemic, and, like those of the left lobe, full of fluid exudation, and of minute red spots consisting of extravasated blood. A considerable quantity of straw-colored serum in the thoracic cavity, and an ounce or more in the pericardium. As to the morbid changes presented by the heart, all blood vessels in the walls of the auricles, and many of those in the walls of the ventricles, turgid with dark-colored blood. (Plate I is a photograph, considerably reduced, of the lungs of experimental pig No. 5.) In the abdominal cavity, the liver dark colored, and twice or more its normal size, but presenting no other morbid changes, except congestion. All mesenteric glands very much enlarged, and the blood vessels of the mesenterium turgid, with dark-colored blood, giving them the appearance of having been ar ificially injected with some dark-colored injecting fluid. No other morbid changes, except some swelling of the ileum, or thickening of the walls of that intestine, caused probably by the presence of some *ascarides*, of which one large specimen (a female) was found in the stomach. All intestines empty, that is, containing no food whatever, but a little yellowish-colored mucus.

6. *Mr. Phillipi's pig, an animal about five weeks old, and sick for some time.*—It was killed by bleeding on May 24. Autopsy immediately after death. Morbid changes: Externally, a big slough on the right side of the head, where, it seems, it had been bitten by another pig. Internally, all lymphatic glands enlarged; nearly everywhere adhesion between the pulmonary and costal pleuras; fully one-half of the whole lung substance, but mostly in the posterior portions of the lobes, and more in the right lobe than in the left, degenerated by the usual and characteristic hepatization, and the non-hepatized parts presenting innumerable small red specks of extravasated blood, and containing a considerable quantity of recent fluid exudation. The blood everywhere carbonized or dark-colored till it had been for some time in contact with the air, when its color changed to a brighter red. Heart and pericardium firmly united with each other, and not separable. On the pleura of the left halt of the chest, not far from the posterior aorta, a whitish nodule of the size of a pea, and of a soft, somewhat pulpy consistency (*cf.* microphotograph No. 2). No morbid changes in the abdominal cavity, except enlargement of the mesenteric glands.

7. *Mr. William Carson's pig No.* 7.—Mr. Carson lives five miles southeast of Tolono, and has losta bout 25 head of swine out of a herd of 50. The pig examined died June 16, and had been dead but one or two hours when the autopsy was made. Morbid changes: Externally, the skin of the lower surface of the b dy covered with small scurfs (eruptions) of the size of half a pea. Internally, a portion of the lung-pleura of the left lobe of the lungs, at one place about the size of a quarter of a dollar, adhering to the costal pleura; about one-fourth of the pulmonary tissue of the left lobe, mostly in its posterior and inferior parts, hepatized and diseased, and about three-fourths of the tissue yet healthy. The lung-pleura of the right lobe adhering with more than one-fourth of

its whole external surface to the costal pleura, and at one place also to the diaphragm. The lung-tissue of the right lobe almost entirely, or more than three-fourths of it, diseased and hepatized; the hepatization in both lobes variegated (marbled) in appearance, and evidently of different age, and in different stages of development, in different parts of the lung-tissue, and even in adjoining lobules, showing plainly that the morbid process had been subject to remissions and exacerbations. Nearly an ounce of serum in the pericardium, the heart large and flabby, and the blood vessels in the walls of the auricles full of blood, presenting the usual dark color. All lymphatic glands swelled. In the abdominal cavity numerous ulcerous tumors in the cæcum and in the colon; those in the latter larger, and those in the former a good deal smaller, but more numerous (*cf.* photograph of ulcerous tumors in colon, Plate II).

8. *Mr. Postlewhaite's pig No.* 1.—Mr. P. lives five or six miles south of Philo, on the Embra River, in Champaign county, Illinois. The pig examined was a suckling pig, about three or four weeks old, and was killed by bleeding on June 27. Autopsy immediately after death. Morbid changes: Externally, a large slough or sore in the left corner of the mouth (see microphotograph No. 3), and another one on the chin. Internally, swelled lymphatic glands and hepatization of a small portion of the lung-tissue of the size of half a cubic inch or a trifle more, where the left anterior lobe joins the left lobe (see microphotograph No. 4). No other morbid changes.

9. *Experimental pig No.* 11.—This animal was about four months old at its death, and was inoculated with lung-exudation of Mr. Carson's pig at 6 o'clock, p. m., June 16. Was taken sick, or showed the first symptoms of disease on June 21, and was killed by bleeding, when already in a dying condition, on July 20. Autopsy immediately after death. Morbid changes: The carcass emaciated to the utmost, the blood thin and watery, and the adipose tissue almost entirely wasted away, notwithstanding that the pig was in an excellent condition and a very fine animal when inoculated on June 16. Internally, all muscles pale and atrophic; lymphatic glands enlarged; lungs partially hepatized; hepatization extending to about one-fourth of the tissue of the left lobe, and to two-fifths to one-half of the tissue of the right lobe; hepatized or degenerated parts presenting everywhere a somewhat whitish or dirty-whitish appearance; no inflammation or fresh exudation in the lungs, the diseased parts evidently undergoing a retrogressive process. On a cut the hepatized parts exuded a whitish, somewhat grumous or sticky and semi-fluid substance, altogether dissimilar to fresh exudation as well in color as in consistency. In the finer bronchial tubes some rather large lung-worms (*Strongyli paradoxi*). (See microphotograph No. 5.) Most of the hepatization in the posterior parts of the lobes. All other parts, such as liver, spleen, stomach, intestines, kidneys, pancreas, spinal cord, &c., without any morbid changes; only in the cæcum a little swelling of the mucous membrane, and in some places congestion. All intestines nearly empty, except the stomach, which contained a little food mixed with coal dust and particles of hay from the bedding. No intestinal worms.

10. *Experimental pig No.* 10.—This animal belonged to the same litter as No. 11, and was a very fine pig when I received it. It was inoculated with same material as that of Mr. Carson's pig on June 16; was taken sick, or showed the first symptoms of disease on June 21, and died in the forenoon of July 24. Autopsy immediately after noon the same day. Morbid changes: Externally, the carcass, to the utmost, emaciated; the skin of nose, mouth, and lower surface of the body bluish purple; just

beneath the sternum a blackish slough, presenting a mortified surface, and extending to the bone, caused probably by decubitus. Internally, all lymphatic glands enlarged; the external surface of the lungs (lung-pleura) almost everywhere, but especially with its lower or inferior portions, adhering to the costal pleura or the wall of the chest. On the external surface of the pleura of the left lobe a layer of cheesy detritus (old plastic exudation) of about one-fourth to one-half of an inch in thickness, one and a half inches in width, and six or seven inches in length, extending and coating the pleura like a shred from the anterior part of the lower border to the posterior upper angle of the left lobe, and forming the means of adhesion between the lung-pleura and the costal pleura, but sticking to the former after a separation had been effected. About one-third of the substance of the left lobe completely hepatized, but most of the hepatized lobules in the lower and posterior parts of the lobe. The right lobe of the lungs affected in a similar manner, and presenting a similar appearance as the left; but the layer of detritus (old plastic exudation) of less thickness and extension. The pericardium very much congested, and showing incipient gangrene where attached to the sternum. The bronchial tubes contain some, but not many, lung-worms (*Strongylus paradoxus*). In the abdominal cavity, the liver three to four times its normal size, and full of cavities, containing worms and lime-deposits in the bile-ducts. In the stomach numerous ascarides, and in the small intestines, but especially in the duodenum, numerous calcareous deposits, the same as in the bile-ducts. No ulcerous tumors in the cæcum and colon. All intestines contained some fluid, but no food whatever.

11. *Experimental pig No.* 12.—Of the same litter as Nos. 10 and 11, and a very fine animal, and in first-class condition when received. It was also inoculated on June 16 with lung-exudation of Mr. Carson's pig, showed first symptoms of disease on June 21, and died July 27, three days later than No. 10, and seven days later than No. 11. Autopsy immediately after death. Morbid changes: Partial adhesion between pulmonary and costal pleuras; hepatization (see microphotograph No. 6) in both lobes of the lungs, extending in the left lobe to about one-half and in the right lobe to about one-third of the pulmonary tissue. Heart and pericardium firmly united with each other by a layer of old plastic exudation of a dirty white-yellowish color, and pericardium very much inflamed. In the abdominal cavity the liver about three times its normal size, presenting on its surface a knotty and in its interior a honey-combed appearance, caused by numerous cavities or enlargements of the bile-ducts, occupied by entozoa. The choledochus inflamed and distended to such an extent as to admit the introduction of a finger; the contents of the gall-bladder a watery fluid, mixed with coagulations of a flaky appearance. Entozoa, or worms: some, but not very many, lung-worms (*Strongylus paradoxus*) in the bronchial tubes, and numerous *ascarides* in the bile-ducts, in the stomach and in the duodenum.

12. *Mr. Bailey's pig No.* 1.—A four-months old boar-pig of the Berkshire breed, which was killed by bleeding on August 25. Autopsy immediately. Morbid changes: Externally, three ulcers or sloughs on the nose and in the face (see microphotograph No. 7). Internally, over two-thirds of the lung-tissue hepatized; some serum in the chest and in the pericardium; and all lymphatic, and particularly the mesenteric, glands morbidly enlarged. No other morbid changes.

13. *Mr. Bailey's pig No.* 2.—This animal was two months old, and was killed and examined the same day as No. 1. Morbid changes: Externally, a hard swelling in the lower jaw, affecting the bone, and ulcera-

tion (sloughing) in the mouth. Internally, the blood dark colored (Mr. B. killed the pig by striking it on the forehead with a club), and about one-fourth of the lung-tissue hepatized. No other morbid changes of any importance, except enlargement of some lymphatic glands.

14.. *Mr Isaac Martin's pig.*—This animal, about four months old and in the last stage of a malignant form of swine plague, was killed by bleeding on September 18. Autopsy immediately after death. Morbid changes: Externally, considerable swelling of the sheath. Internally, the blood dark colored; all lymphatic glands very much enlarged. In the lungs about two-fifths of the tissue of the left lobe and about three-fifths of the tissue of the right lobe diseased, and in some parts hepatized to such an extent as to be perfectly solid. The other non-hepatized portions, that is, those in which the structure of the lung-tissue was yet normal, or nearly normal, full of fresh and yet fluid exudation, and presenting innumerable small red specks of extravasated blood, each speck or spot of the size of a pin's head or smaller, and situated not only near the surface, but everywhere, the same as in other cases, in the interior of the lung-substance. The pleura coated with exudation, and rough at several places; some serum in the pericardium, but the heart and its auricles without any conspicuous morbid changes. In the abdominal cavity numerous and exceedingly large, thick, and well-developed ulcerous tumors, presenting a black surface, in the cæcum and in the colon—those in the cæcum—(see microphotograph No. 9) being the largest—several (about a dozen) small entozoa (*Trichocephalus crenatus*) in the cæcum; and mesenteric glands very much enlarged. No other morbid changes of any importance.

15. *Mr. Munday's pig.*—This animal, about five or six months old, was killed by bleeding on October 13. Mr. M. lives in Effingham county, between Watson and Effingham. Autopsy immediately after death. Morbid changes: About half of the lung-tissue hepatized; in the non-hepatized parts considerable fluid exudation and numerous extravsations of blood, presenting themselves to the naked eye as minute red spots; hepatization and other morbid changes more developed in the right than in the left lobe of the lungs; a small quantity of serum in the pericardium, and a comparatively large quantity (over a pint) in the abdominal cavity; all lymphatic glands, but particularly those of the mesenterium, considerably enlarged; a number of worms (*Trichocephalus crenatus*) in the cæcum (see microphotograph No. 11); the mucous membrane of the cæcum and in some parts of the colon slightly swelled, and the contents (feces) of both intestines, but especially of the colon, hard and lumpy. No other morbid changes.

16. *Mr Beaty's pig.*—A small animal, about four or five months old, was killed by bleeding on November 6. Mr. B. lives in Henderson county, about four miles from Oquawka. Autopsy immediately after death. Morbid changes: Externally, swelling and ulceration in the nose and in the scrotum (the pig had been ringed and castrated a few weeks before it was taken sick, but at a time when swine plague was prevailing in Mr. Olson's herd, about a mile and a half from Mr. Beaty's place). Internally, the blood of normal appearance; all lymphatic glands, but especially the inguinal glands, very much enlarged; the lungs completely filling the space in the thoracic cavity in the left lobe, about half of the lung substance hepatized, and the non-hepatized tissue containing a considerable quantity of fresh and fluid exudation and numerous small red spots of extravasated blood (see photograph, Plate III); in the right lobe similar morbid changes, only a little less extensive; in the pericardium over an ounce of straw-colored serum. In the abdominal cavity some

serum; the mesenteric glands enlarged; a number of dead *ascarides* (the pig had been treated with carbolic acid for a few days) and small lumps of slate-colored feces in the posterior part of the colon; and a yellowish fluid largely composed of bile, but no food, in the stomach and small intestines. No other morbid changes of any importance.

The results of these sixteen *post mortem* examinations are probably sufficient to show that the morbid changes observed in 1880 are essentially the same as those found in 1878-'79, only, on an average, a little less complicated, because the morbid process, upon the whole, was less acute and less malignant. The cases given have been chosen because they cover the whole time from April to November, and all of them have furnished material for special examination, and most of them also for inoculation. Others might be added, but as no morbid changes not met with before, or not found at one or another of those *post mortem* examinations the results of which have been given, have come to light, to do so would simply be repeating the same thing over and over again.

EXPERIMENTS.

The experiments made since the first days of April at my experimental station, located till September on the grounds of the Illinois Industrial University, at Urbana, Champaign county, Illinois, and afterwards on private grounds near my boarding place in Urbana, have been made with several objects in view.

1. My former experiments and observations proved that swine plague can be, and is, communicated through the digestive canal, and through sores, wounds, and scratches, even of the smallest character, in the skin and mucous membranes, but they did not show that the infectious principle was able to enter the organism of a healthy animal through the unwounded and perfectly uninjured skin and respiratory mucous membranes, and produce disease by simply being inhaled where healthy and diseased swine were compelled to breathe the same atmosphere. Notwithstanding an infection or a communication of swine plague by mere inhalation may be possible, I made it an object to ascertain whether the disease can be communicated not only by an absorption of the infectious principle through the digestive canal and through external sores, wounds, and lesions, but also by an absorption of the same through the uninjured skin and whole and healthy respiratory organs, because if such should prove to be the case, even a strict separation of healthy swine from diseased ones would not be of much avail as a measure of prevention, and, contrary to my former observations, could not be relied upon. On a farm a separation can seldom be carried so far as to prevent the inhalation of an infectious principle that is carried through the air, and evidently attracted and absorbed by wounds and scratches, even if the source of the infection, that is, the diseased herd of swine from which the infectious principle emanates, is over a mile off.

2. In my former experiments, but especially those conducted during the fall of 1879 and the winter of 1879-'80, I had very good success in preventing a development of the morbid process of swine plague in animals which had been exposed to infection, and very likely had become infected, and thus, in arresting the progress of the disease within infected herds by treating those animals not yet plainly diseased with antiseptic medicines, such as carbolic acid and hyposulphite of soda, &c. (*cf.* my former reports). I therefore concluded to subject the same medicines and a few others to a thorough test as to their practical value as preventives.

3. In the fall of 1878 and in the winter of 1878-'79 comparatively few

recoveries from swine plague were observed—the disease was very fatal—but in the spring, summer, and fall of 1879 and in the winter of 1879–'80 recoveries were more numerous, but it was very seldom noticed that an animal, once recovered, contracted the disease a second time, and only once that one and the same animal contracted the disease three times, but each time before it fully recovered from the previous attack. In every case, however, the second attack proved to be a comparatively mild one and did not become fatal, at least not in those cases which came under my observation. It was therefore another object to ascertain more positively whether an animal once recovered from an attack of the plague will contract it again if inoculated or exposed to infection, or will, as a rule, resist the influence of the infectious principle and possess immunity. Further, if such should prove to be the case, I considered it as important to determine by experiments whether a very mild attack of swine plague, such a one as leaves hardly any morbid changes behind, will produce just as much immunity from infection as a severe one, or whether it is only the permanent morbid changes left behind by the latter that protect the animal in the future.

4. My former experiments seemed to indicate that an inoculation with cultivated material (cultivated swine-plague schizophytæ) produces a milder form of disease than a natural infection or an inoculation with unadulterated material taken directly from the body of a diseased or dead animal. Hence, if it should be found that a mild attack, one that does not leave any serious morbid changes behind, protects an animal against subsequent infection, and if an inoculation with cultivated schizophytæ produces invariably, or, as a rule, a comparatively mild form of disease, such inoculations might be made use of as a means of prevention, or rather of reducing the losses caused by swine plague. It was therefore deemed of importance to contribute as much as possible to the solution of that question.

5. As it is claimed by some people, misled probably by the two misnomers "hog cholera" and "chicken cholera," that the disease known by the latter name is identical to swine plague, I have endeavored to dispose of that question.

I will, as heretofore, first relate my experiments and then state the conclusions arrived at. In order to avoid too much repetition I shall omit a daily record of all pigs not showing any disease. Hence, all those experimental pigs not mentioned every day either did not show any morbid symptoms and appeared healthy, or did not present any changes since the date at which they were last mentioned.

My experimental pig pen, a frame building 16 feet long and 20 feet wide, and divided into eight pig-pens, a place for corn and a chicken-pen, or ten apartments each 4 feet wide and 8 feet long, was finished on April 6.

On the morning of April 7 I received five pigs from Mr. Lawrence, head farmer of the Illinois Industrial University, and put them respectively in pens Nos. 3, 4, 5, 6, and 7. The pigs, for convenience sake, received the same numbers as the pens which they occupied. Pens Nos. 1, 2, and 8 remained empty. Pigs Nos. 4 and 5 were inoculated at 1.30 p. m., with lung exudation of Mr. Dillon's pigs Nos. 1 and 2 (*cf.* account of *post-mortem* examination of those pigs).

April 8.—Pig No. 4 eats and drinks well; the others do not seem to feel at home, being confined one by one in a small pen. They have therefore not consumed all the food given them. They also cough some, like pigs infected with lung-worms (*Strongylus paradoxus*), but the cough is decidedly different from that usually heard in swine plague.

All the animals came from the herd of the University farm, in which no swine plague had existed for over a year, and which remained exempt up to this date. Further, no swine plague had existed in the neighborhood for a year, so the cough could not have been the result of that disease. In the evening pigs Nos. 4 and 5 appeared to be feverish and were shivering, but it was not plain whether on account of the chilly night air, or already in consequence of the inoculation.

April 9.—It having been asserted that so-called chicken cholera and swine plague were identical diseases, I fed some chickens which I had procured, with half of the lungs, the heart, and the liver of Dillon's pig No. 3 (see account of *post-mortem* examination of that pig). Commenced cultivating swine-plague schizophytæ, and charged 2 ounces of fresh milk, 2 ounces of water, and the albumen of an egg, each with two drops of the pulmonary exudation of Dillon's pig No. 3. In the evening experimental pig No. 5 is shivering and appears to be cold.

April 10.—Pig No. 4 appears to be indisposed, and shivers. All the pigs, Nos. 4 and 5 included, eat and drink well.

April 11.—No. 5 seems to be indisposed, is loath to get up, and shivers. One of the chickens does not go to roost, and does not seem to be well; on examination it is found that it is affected with what is known as "scaly legs." Took scabs and examined them under the microscope for mites, but did not find any.

April 12.—Pig No. 4 does not eat well, and pig No. 5 is shivering, apparently cold. All other pigs are doing well. Fed to pig No. 7, a large sow pig six or seven months old, the infected albumen, and put the albumen of another egg into the vessel, a quinine bottle, which still contained a drop or two of the infected albumen.

April 13.—Pigs Nos. 4 and 5 show insufficient appetite; the former shivers.

Received six more pigs of the Berkshire breed, each about three and a half or four months old, from Mr. Dallenbach, and placed and numbered them as follows: Two in pen No. 1, to be known as No. 1 A and No. 1 B; two in No. 2, and designated as No. 2 A and No. 2 B; and two in pen No. 8, to be called No. 8 A and No. 8 B.

April 14.—Pig No. 5 decidedly sick and feverish; seems to be weak in the hind quarters. No visible change in pig No. 4. Inoculated pig No. 2 A with swine-plague schizophytæ cultivated in milk, and pig No. 2 B with schizophytæ cultivated in water. All inoculations, unless otherwise stated, have been made on the outside of an ear and with a small spoon-shaped, but sharp inoculation needle, made originally for the purpose of inoculating sheep with the virus of sheep-pox.

April 15.—Pig No. 5 very sick, and does not like to rise when called upon; pig No. 4, though still lively, is also evidently ailing. Pig No. 7 received in its trough the albumen infected on April 12, and the albumen of another fresh egg was put in the bottle, which, as before, still contained a few infected drops.

April 16.—Pig No. 5 is very sick, but takes a little food in the evening. Is nearly always lying in a corner of its pen during the day, and does not like to get up when asked to do so. When on its legs walks to the trough to get a swallow of water, and then returns to its corner and lies down again. It shows considerable weakness in its hind quarters, and shivers when lying down. Its cough (as has been stated, all five pigs received from Mr. Lawrence cough some, and very likely have lung-worms) has changed, sounds hollow, is weak, and characteristic of swine plague. Pig No. 4 is yet active, and eats and drinks some, but not near as much as any of the other pigs. Its cough, too, is getting

hollow and weak, and sounds like swine plague. Both pigs, Nos. 4 and 5, have sore noses. (It may be stated here that all five pigs received from Mr. Lawrence had rings in their noses when I received them.)

April 17.—Pig No. 4 has suddenly become worse, and is even worse than No. 5. It hardly touches its food, is thin, gaunt, and emaciated, and coughs that peculiar weak cough characteristic of an advanced stage of swine plague. Pig No. 5, though lying most of the time shivering in a corner, has eaten a little, and consumed about one ear of corn during the day. Both pigs exhibit a thumping motion of the flanks. All other pigs apparently healthy. Pigs Nos. 2 A and 2 B have a ravenous appetite, and though the smallest of all, eat fully as much as any. Nos. 1 A and 1 B seem to be healthy, but one of them has commenced to cough; has not coughed before, neither have any of the six pigs received from Dallenbach.

Dillon's pig No. 3 (see account of *post-mortem* examination) was killed on the 9th of April at 10.30 a. m. at Mr. Dillon's place, a few miles north of Champaign, and about 3½ miles from my experimental pig-pen. The carcass was then thrown into the buggy, and taken to the experimental station for dissection. Arriving there a little before noon, having to dispose of horse and buggy, and finding the dissecting room of the veterinary building locked—the latter and my experimental pig-pen were only a few rods apart—I put the dead pig in the trough of pen No. 1, then not occupied, till I would be able to make the autopsy. When the carcass was removed to the dissecting-room, immediately after noon, I found that the trough had become soiled with a few drops of blood, which were left there on purpose, because I expected to get more pigs, and wished to see whether so small an amount of blood, after exposing it to the influence of the atmosphere for a few (four) days, would be able to cause an infection, if left where it was to become dissolved by and mixed with the water for drinking. On April 12, as already stated, pen No. 1 became occupied by pigs No. 1 A and No. 1 B.

April 18.—Pig No. 1 B is coughing and does not eat well; pig No. 4 snuffles, and its nose is much swollen, very sore, and ulcerating; pig No. 5 eats and drinks a little; pigs Nos. 2 A and 2 B do not show any symptoms. All others apparently healthy.

April 19.—Both pigs, Nos. 4 and 5, very low, but No. 4 especially so; the latter does not eat anything; breathes very hard; its nose is much swelled, and every respiration causes a snuffling sound. No. 5 eats a trifle, but lies most of the time shivering in a corner. Its nose is not sore, but looks very pale. Both pigs are emaciated. The other pigs exhibit no change, and all those not inoculated appear to be perfectly healthy. Pig No. 7 received again a dose of infected albumen, charged on April, 15, and once more the albumen of a fresh egg was put into the empty bottle, the same as on April 15.

April 20.—Pig No. 4 apparently in a dying condition; cannot live much longer; does not stir as formerly when urged to get up. No. 5 and all others the same as yesterday. (After about a week of dry weather a pouring rain; hail, thunder-storm, hurricane during the night, followed during the day by bright and clear weather.)

April 21.—Hardly any change; pig No. 4 has touched neither food nor water for four days; lies in a corner in a soporous condition, and does not stir when urged to get up; it breathes with great difficulty and with a pumping motion of the flanks; emaciation is very great; in the afternoon a very fetid diarrhea sets in (diarrhea, but not so fetid, has existed for the last twenty-four hours). No. 5 is neither worse nor better; drinks a great deal, and eats a small ear of corn in about 24 hours. Its nose

is exceedingly pale, and the animal, when lying down, is almost constantly shivering, as if suffering from ague chills. No 7. shows swelling and ulceration of the nose, and is coughing a good deal; it received three times (April 12, 15, and 19) infected albumen. No. 1 B has not shown any change; is coughing, but eats and drinks. Nos. 2 A and 2 B eat vigorously. Nos. 8 A, 8 B, and Nos. 6 and 3 to all appearances are perfectly healthy.

April 22.—No. 4 still alive, but has not touched any food; neither has No. 5. Like No. 4, it lies in a corner in a soporous condition, and neither eats nor drinks. No 4 seems to have great difficulty in exhaling—expelling the air from the lungs; the fetid diarrhea continues. The other pigs do not present any change.

April 23.—No. 4 still lies in its corner and cannot be induced to get up. No. 5 is weaker than yesterday. No. 1 B coughs a good deal, and No. 7 is indisposed, mopish, and does not eat well; both pigs are evidently affected. All others are well.

April 24.—Last night a tremendous rain and hurricane. Pig No. 4 found dead in its pen. It was dying in the evening of April 23, and probably died early in the night, before the rain and hurricane commenced. (For changes see account of *post-mortem* examination No 4.) Pig No. 5 lies in its corner, shivering as usual, and shows no change. Pigs Nos. 2 A and 2 B do not eat their food; seem to feel chilly, and are shivering. No change in the others. At 9 o'clock a. m., fed left lobe of the lungs and the liver of pig No. 4 to the chickens.

April 26.—Pigs Nos. 2 A and 2 B lack appetite, and do not eat their food. B, especially, droops its ears, seems to feel chilly, and coughs. No change in No. 5.

April 27.—Pigs Nos. 2 A and 2 B evidently affected; both droop their ears and are shivering. No. 2 B is quite sick and coughs considerably; it is mopish, and does not like to move. No. 5 staggered from its corner to its trough to drink, but did not eat anything.

April 28.—Pig No. 2 A presents no change; No. 2 B does not eat, and lies nearly all day in a corner shivering and shaking. No. 5 is apparently no worse; seems to be more inclined to move, but cannot be induced to take any food.

April 29.—No essential change in any of the pigs. No. 2 B seems to be a little worse, and is undoubtedly a sick pig. No. 5 is about the same as yesterday, perhaps weaker. Nos. 7 and 6 are coughing.

April 30.—No essential change. Pig No. 2 A eats about half a meal, and No. 2 B eats hardly anything at all. No. 5 is exceedingly weak, and collapsing; its temperature at noon was found to be 95° F. It died at 7 p. m. (For morbid changes see account of *post-mortem* examination No. 5.)

May 1.—Inoculated in the morning pigs Nos. 2 A and 3 with the fresh pulmonary exudation of pig No. 5. The operation was performed as soon as the exudation could be obtained after the chest had been opened. As every inoculation made with the exudation of the lungs proved to be successful, that is, productive of an attack of swine-plague, in my former experiments as well as in the present (*cf.* account of pigs Nos. 4 and 5), I concluded to try preventives. Pig No. 3 had never been inoculated, neither had it ever been sick, notwithstanding its pen (No. 3) is separated from pen No. 4 only by a board partition about 3 feet 10 inches high, in which pig No. 4 became sick and died.

Pig No. 2 A was inoculated on April 14 with swine-plague schizophytæ, cultivated in milk, and apparently had a very slight attack, but could hardly at any time be considered as a sick animal. It is a boar-pig and

weighs about sixty pounds, while its companion, No. 2 B, is a sow-pig weighing about 40 pounds. Commencing at noon May 1, both pigs together received three times a day in their water for drinking about ten drops of carbolic acid, or rather of a solution of carbolic acid, composed of .95 per cent. of the pure crystallized acid and 5 per cent of water. For pig No. 3 I prepared an iodine solution, composed of 10 grains of iodine, 12 grains of iodide of potassium in half an ounce of water, and commencing at noon of May 1 gave it three times a day, in its water for drinking, a quantity sufficient to contain each time about 1 grain of iodide of potassium and a little less than a grain of iodine. As each time some water remained in the trough which had to be poured out again, only about half of that quantity was actually consumed. Pig No. 3 is a sow-pig, and weighed on May 1 about 60 pounds, or perhaps a little more. The carbolic acid and iodine treatment was commenced within five and a half hours after the inoculations had been made. In the morning the albumen of a fresh egg was put in a clean vial with a glass stopper, and charged with two drops of the pulmonary exudation of pig No. 5.

May 2.—No change for the worse in any of the pigs. Pigs Nos. 2 A and 2 B have better appetite. No. 2 A coughed a few times.

May 3.—Inoculated pigs Nos. 1 A and 1 B with the albumen charged with 2 drops of pulmonary exudation on May 1; transferred pig No. 2 B to pen No. 5, which had been left in exactly the same condition in which it was found when the carcass of pig No. 5 was removed. Pig No. 2 B is henceforth pig No. 9, and No. 2 A is simply No. 2. No essential change observable in any of the pigs.

May 4.—Pig No. 9 (old No. 2 B), which had a mild attack of swine plague after an inoculation with cultivated material, seems to be improving, and, though not entirely well, is not very sick. The carbolic acid treatment is continued. Pig No. 6 (a large sow and never inoculated, but ringed before I received her) has shown some symptoms of sickness for several days (since April 29), and is now evidently diseased. It is inclined to mope, eats very little, and its nose is ulcerating. No. 7 seems to be improving; all other pigs are doing well.

May 5.—Pig No. 6 is worse; has no appetite; don't eat anything. No other changes.

May 6.—No changes.

May 7.—Pig No. 6 is worse; lies almost always in its corner, and does not touch its food. Pig No. 9 shows again more indisposition, and does not eat well, but takes some food and water. No further changes.

May 8.—All pigs about the same as yesterday, except No. 7, which is mopish, less lively than during the last few days, and is eating very little. None of the inoculated pigs (Nos. 2, 3, and Nos. 1 A and 1 B) show any symptoms of disease.

May 9.—Pig No. 6 is decidedly worse, rises now and then from its corner to get a swallow of water, and then lies down again. It does not eat anything, and emaciation is apparent. Pig No. 7, which, so far, has received every three or four days a dosis of albumen, infected with cultivated schizophytæ, is evidently diseased; still, it eats and drinks some, but never more than about half an ordinary meal. Its nose, too, is very sore and ulcerating.

The chickens, which have been fed repeatedly with highly infectious parts of dead pigs, are all healthy, that is, free from any disease resembling swine plague; but the effect of being confined in a narrow pen, of being deprived of exercise, and of not receiving enough silica and lime in their food, commences to become apparent; one or more of them com-

menced to eat the feathers of their companions, and therefore were given their liberty.

May 10.—No essential changes, except as to pig No. 6, which is improving, and though yet very sick, has again commenced to eat.

May 11.—Pig No. 3, it seems, does not like its iodine, and for the last two or three days has not been eating and drinking as much as before, but shows no symptoms of swine plague. No. 9 appears to be slightly improving, but coughs now and then. No. 7 is moping, has poor appetite, and coughs. No. 2 is very vigorous, and greedy for its food and drink; it seems to like the carbolic acid.

May 12.—No change.

May 13.—The iodine treatment does not seem to agree with No. 3; it is, however, continued. The pig has not very good appetite, and drinks very little. No. 6 is improving and eats about half as much as a pig of its age and size ought to eat. No. 7 has less appetite.

May 14.—No. 2 is as well and as vigorous as ever. No. 3, which has coughed a few times during the last few days, drinks very little, and, though not eating enough, has a fair appetite, and is very lively. The pig is evidently not sick, at least does not show symptoms sufficient to justify one in pronouncing it diseased with swine plague. The iodine does not agree with it. No. 6 is slightly better; No. 7 is worse.

May 15.—Pig No. 7 does not touch its food, and is evidently worse; emaciation is visible. No change in any of the others.

May 16.—Pig No. 7 is still getting worse; does not eat anything; is very indifferent to its surroundings, and it takes some coaxing to induce it to get up.

May 17.—Pig No. 6 is improving. No. 7 accepts an egg, but does not take any other food. (As the chickens laid some eggs, I used the latter for experimental purposes, and also to tempt the appetite of some very sick pigs.)

May 18.—Pig No. 7 is slightly improving; it accepts another egg, eats some corn, and comes to the trough when water is poured in. No other changes.

May 19.—Pig No. 7 is improving; eats some, and is more lively. No. 6 can be considered as convalescent, and has fair appetite. No other pigs are ailing.

May 20.—Big rain and thunder storm during the night. Pig No. 7 is improving, and all other pigs are doing well, and are ready for another experiment, but no material of sufficient malignancy is available. One other chicken has scaly legs, but the mites, said to constitute the cause, are not found.

May 21.—All pigs are doing well. Nos. 6 and 7 are eating again, but their appetite is not yet fully restored. The carbolic acid and iodine treatment of pigs Nos. 2, 9, and 3, continued till date, is dispensed with.

May 22.—Pigs Nos. 2 and 9, not receiving any more carbolic acid, seem to miss its taste in their water for drinking, and do not seem to be satisfied. Pig No. 3, however, drinks more, and does not care for its dosis of iodine.

May 23.—No change. Pig No. 3, not getting any iodine, eats and drinks as well as any of the other pigs. One chicken with scaly legs, the one affected first, and for some time confined in pig pen No. 4, got into pen No. 6, and was killed by pig of the same number.

May 24.—Obtained new material at Mr. Philippi's place (*cf.* account of *post-mortem* examination No. 6), and inoculated at 5 o'clock p. m., pigs Nos. 2, 3, 9, 6, 7, 8 A and 8 B. Pigs Nos. 2, 3, and 7 receive three times a day a dosis of carbolic acid in their water for drinking; pigs

Nos. 8 A and 8 B are treated with benzoate of soda, while Nos. 9 and 6 receive no medicines whatever. No. 9 is the smallest, and No. 6 is the largest, of the pigs.

May 25.—Rain all day. All pigs seem to be doing well, and no apparent reaction has occurred from the inoculation. Nos. 6, 7, and 9, however, have not yet completely recovered. No. 9 especially has been coughing now and then since first affected, and does not seem to get over it; neither has it grown any, and is therefore small and runty.

May 26.—Again a heavy rain. None of the pigs ailing, except those which have not fully recovered.

May 27.—No change.

May 28.—None of the pigs show any symptoms of active disease, and all are doing well, except Nos. 9, 6, and 7.

May 29.—No change.

May 30.—Nos. 6, 7, and 9 cough some, and do not eat quite enough. The others are apparently healthy, and doing well.

May 31.—No. 9 is evidently worse, is coughing a good deal, and eats very little. The other pigs are doing well.

June 1.—No essential change in any of the pigs. No. 9 coughs considerably, and eats very little, but is otherwise lively.

June 2.—No. 9 again shows plain symptoms of active disease, is moping, coughs a good deal, and has very poor appetite, but is yet moving about. The other pigs are apparently healthy, at least are without any noticeable symptoms of active disease.

June 3.—No. 9 does not eat anything, and is very sick again. All others are doing well.

June 4.—No. 9 commences to eat a little.

June 5.—No. 9 improving, is more lively, and eats more than yesterday. No change in the others.

June 6.—No. 9 improving; eats more than on any one day during the last ten days, and is more lively, but is lean and coughs quite often. Other pigs doing well.

June 7.—All pigs eat well, and with the exception of No. 9, which is yet coughing, none of them exhibit any symptoms of disease.

The medicines, carbolic acid to Nos. 2, 3, and 7, and benzoate of soda to Nos. 8 A and 8 B, are dispensed with. Pigs Nos. 8 A and 8 B, which received the benzoate of soda, did not seem to object to it, and do not show any bad effect, except a slight diarrhea, which made its appearance soon after the treatment was commenced, and continued as long as the medicine was given.

June 8.—No changes.

June 9.—As it becomes apparent that a pig which once had swine plague does not easily take it again, or, if it does, only in a mild form, I found it necessary to procure new pigs, and bought four nice Berkshires, all sow pigs, belonging to the same litter, and nearly three months old, of the Hon. James R. Scott, of Champaign.

June 10.—No change; one of the chickens, the best one, is missing, and was probably stolen.

June 11 to 14.—No changes worth mentioning, except that pig No. 9 has diarrhea and coughs a good deal.

June 15.—Received my pigs from Mr. Scott; designated the same as Nos. 10, 11, 12, and 13, and put them all four together in a box-stall of the Veterinary Infirmary of the Illinois Industrial University.

June 16.—Succeeded in procuring fresh material for inoculation in Mr. Carson's herd, five miles southeast of Tolono (*cf.* account of *post mortem* examination No. 7), and inoculated at 6 o'clock p. m. pigs Nos.

2, 3, 9, 6, 7, 8 A, 8 B, 10, 11, and 12. Pigs Nos. 1 A, 1 B, and No. 13, the latter being one of the new pigs, were not inoculated. All pigs, with the exception of No. 9, which is yet ailing, are apparently well.

June 17.—All pigs seem to be well, except No. 9, which is yet coughing considerably, but has a fair appetite. No. 6, too, appears to be not very lively; the same struggled hard while held for inoculation and got slightly hurt.

June 18.—No change; No. 6 is a little dull, and acts as if not feeling well.

June 19.—No change.

June 20.—All pigs eat well, and none of them show any symptoms of disease, except No. 9, which has never fully recovered, and No. 6, which is yet lame and less lively than usual.

June 21.—Nos. 10, 11, and 12 seem to be slightly indisposed; have lost the curl out of the tail, but eat and drink some.

June 22.—All pigs—partly due, perhaps, to exceedingly hot weather—eat less than usual, but Nos. 9, 10, 11, and 12 eat very little; the last three especially do not seem to care for food (their principal food consists of ground corn and ground oats mixed), and prefer to lie down and rest.

June 23.—Nos. 10 and 11 have not eaten anything since last night; No. 12 has been at the trough, but has eaten very little, if any. The other inoculated pigs, Nos. 2, 3, 9, 6, 7, 8 A, and 8 B, also seem to lack appetite; at any rate, they do not consume more than about half their usual quantity of food. Whether the want of appetite is caused by the inoculation having been effective or merely by the high temperature is difficult to decide.

June 24.—Pigs Nos. 10, 11, and 12 have not eaten anything, and No. 13 commences to show poor appetite. (No. 13 was not inoculated, but occupied the same pen—the box-stall in the infirmary building—as Nos. 10, 11, and 12, and eats and drinks out of the same trough and partakes of the same food and water.) All four commence to huddle together in a corner and to hide their noses in the bedding, in sick-pig fashion. Some of the dung found in their pen is in shape of small, hard, irregular lumps, and very dark colored. As to the other pigs no conspicuous changes are observable. No. 9, which never fully recovered, is coughing some, and eats very little. The others, too, with the exception of Nos. 1 A and 1 B, which have not been inoculated, show diminished appetite.

June 25.—Pigs Nos. 10, 11, and 12 have not touched their food; have commenced to emaciate and are getting thin. No. 13, too, has poor appetite and eats very little. Removed pig No. 10 to the empty pen No. 4 in the experimental pig-pen, which was first thoroughly scrubbed and cleaned. Commenced treating pigs Nos. 11, 12, and 13 with carbolic acid by giving it to them in their water for drinking. It may here be remarked that Nos. 11 and 12 have shown symptoms of sickness for at least four or five days (since the 21st), and are undoubtedly diseased with swine plague. No. 13, although not inoculated, was also ailing for two days and suffering from the same disease. In giving the carbolic acid it was my object to try that medicine on a few well-established cases of swine plague. No. 10 does not receive any medicine whatever. As to the other pigs, they do not eat much, but seem to be perfectly healthy, except Nos. 1 A and 1 B, but none of them, except No. 9, exhibit any plain symptoms of swine plague. No. 9 is about the same as it has been for some time, and is neither worse nor better. The symptoms exhibited seem to be the product of old morbid changes, and not of any active morbid process.

June 26.—Pigs Nos. 10, 11, and 12 are very thin, and do not touch their food. No. 10, which occupies by itself pen No. 4, is the thinnest, and shows considerable weakness in its movements. No. 13 has poor appetite and eats but little.

June 27.—Pigs Nos. 10, 11, 12, and 13 take a little shelled corn, but do not eat their chopped food. Nos. 11, 12, and 13 accept and consume an egg.

June 28.—Heavy rain during the night. Pig No. 10 is very low, coughs a great deal, and is apparently in distress. Nos. 11, 12, and 13 have eaten a little, and again consume an egg. Another egg offered to No. 10 is refused. The other pigs about the same, only Nos. 8 A and 8 B eat less than any of the rest. No. 9 is coughing; have heard no cough from Nos. 11, 12, and 13.

June 29.—Pigs Nos. 1 A and 1 B all right in every respect. Nos. 2, 3, 6, 7, 8 A, and 8 B without any plain symptoms of disease, and appetite improved. Pig No. 10 worse and coughing, and does not eat anything whatever, and Nos. 11, 12, and 13 hardly touch their food.

June 30.—No. 10 has diarrhea, and lies all day almost motionless in its favorite corner. An egg put in the pen has disappeared, and must have been eaten. Nos. 11, 12, and 13 hide in their bedding, as usual, and it takes considerable coaxing to induce them to get up. All others the same as before.

July 1.—No. 10 very low; has much diarrhea, and does not get up unless compelled. Nos. 11, 12, and 13 eat a trifle. No. 11 has diarrhea, and all have a tendency to hide their heads in the bedding; none of them cough. All other pigs without any change. During the night another heavy rainfall.

July 2.—No. 10 eats a little shelled corn, and seems to be more lively. Nos. 11, 12, and 13 also appear to be a little better and eat some chopped food (a small handful) and a little young clover. All seem to be slightly better and more lively; at least none are worse. At noon No. 12 was licking the floor (vitiated appetite, a frequent symptom), and a few drops of carbolic acid poured down were greedily licked up.

July 3.—All the smaller pigs—Nos. 10, 11, 12, and 13—have diarrhea. No. 10 coughs, but not often. Have heard none of the others cough. No. 9 has somewhat better appetite, but is otherwise the same as before.

July 4.—No perceptible change.

July 5.—All of the small pigs eat just a mere trifle. No change.

July 6.—No change whatever.

July 7.—No. 10 eats a little, but is very dumpish and weak. Nos. 11, 12, and 13 have a bad diarrhea, and the first two are very much emaciated. All three eat just a mere trifle, but do not seem to be thirsty, while No. 10 commences to drink a good deal. No. 13, too, begins to act a little dumpish, but less so than No. 10; while No. 11, apparently the sickest pig in the lot and surely the most emaciated, is the liveliest, and not dumpish at all.

July 8.—No change since yesterday. No. 10, is very thirsty and eats a little shelled corn. Nos. 11, 12, and 13 have not touched their food, except in the evening, when the three together consumed half a handful of corn-meal and ground oats mixed with water.

July 9.—No change. At 11 o'clock a. m. a tremendous storm.

July 10.—Pig No. 10 has diarrhea and is very weak. Nos. 11, 12, and 13 are also getting very weak. No. 10 is thirsty and eats some shelled corn.

July 11.—No. 10 appears to be blind; it is very thirsty; its appetite

is rather increased, at least not diminished, but its excrements are almost as thin as water. No. 11, although the most emaciated, eats, perhaps, more than either Nos. 12 or 13, which eat next to nothing. All have diarrhea.

July 12.—No. 10 about the same as yesterday, perhaps more dumpish. Nos. 11, 12, and 13 emaciate rapidly and hardly touch their food. All have diarrhea, but the discharges have yet a white yellowis color. All other pigs without any change.

July 13.—No. 10 the same as yesterday, but more loath to get up, and slower and more undecided in its movements. Nos. 11, 12, and 13 more emaciated, and more diarrhea. All four pigs exceedingly weak, and scarcely able to stand upon their legs. The others are unchanged and apparently well, except No. 9, which is coughing, as usual.

July 14.—No. 10 very weak and trembling to and fro when rising. No. 12, which was originally the best and strongest pig of the four, and is less emaciated than any of the others, appears to-day to be the worst of all; it had a bad sneezing fit. No. 11 is exceedingly poor, but more active than any of the others. Nos. 11 and 13 eat a little in my presence, but No. 12 cannot be prevailed upon to touch the choicest food—an egg and some young and juicy clover. Nos. 10, 12, and 13 have been dumpish for several days and act as if their livers were affected. The weather is very hot and sultry, and the thermometer shows 100° F. in the shade.

July 15.—No visible changes in Nos. 10, 11, and 13, except that the two latter—due, probably, to the cooler weather—show a little more liveliness and eat a trifle. No. 12, though the least emaciated, and originally the best and strongest pig, is to-day decidedly the sickest; it reels and staggers and is scarcely able to stand. It has again had a violent sneezing fit. No. 11, too, is very weak and can hardly stand, but acts more lively than yesterday.

July 16.—Nos. 10 and 12 exceedingly weak, and can rise and stand only with difficulty. Neither of them touch their food. No. 10 drinks some. No. 12 had another severe sneezing and coughing fit, and has undoubtedly lung worms (*Strongylus paradoxus*). No. 13 eats a little and drinks a good deal. The urine of No. 12 is of a yellowish-brown color.

July 17.—Pigs Nos. 11 and 13 a trifle livelier, and eat and drink some. No. 12 evidently still worse, and perfectly blind; one eye is closed entirely, and the other nearly so. No. 10 is very thirsty, and otherwise the same as before. Pig No. 3 is unusually quiet; but eats and drinks well.

July 18.—Pigs Nos. 11 and 12 more lively, but to the utmost emaciated, especially No. 11, which is nothing but skin and bones. No. 12 drinks a little, but takes no food, and cannot rise without assistance. No. 10 is declining more and more, and its diarrhea is getting fetid. Of late it has been drinking considerably, but has not taken any food, and cannot be prevailed upon to get up. No. 9 is still coughing, but eats its food; and No. 3, formerly a noisy pig, remains unusually quiet, but has good appetite, and shows no symptoms of disease. All others apparently healthy.

July 19.—Pig No. 10 discharges a large number of worms (*Ascarides*); No. 11 is exceedingly weak, No. 12 has violent coughing fits, and No. 13 is improving.

July 20.—No. 10 is very weak; has eaten very little, if anything, since last night, and don't seem to have as much desire to drink. No. 11 is so weak as to fall down when slightly pushed while standing. No. 12 is exceedingly dumpish, emaciates very fast, and has no appetite what-

ever. No. 13 is improving. Killed No. 11 by bleeding at 8 o'clock a. m. (*cf.* account of *post mortem* examination No. 9). Inoculated at noon pigs Nos. 1 *a*, 2, and 3 with the pulmonary exudation of pig No. 11.

July 21.—Pig No. 10 exceedingly weak and very dull, but eats and drinks some. Pig No. 12 is very low; will rise only if helped on its legs, and then immediately lies down again. Pig No. 13 decidedly improving, is getting frisky, eats some, and drinks a good deal. All other pigs as usual.

July 22 and 23.—Hardly any change in any of the pigs, except No. 13, which is getting better, and gaining strength and appetite.

July 24.—Pig No. 10 died in the forenoon (*cf.* account of *post mortem* examination No. 10). Pig No. 12 is very low, and hardly able to move, when helped on its legs. No. 13 is improving.

July 25.—Pig No. 12 very low. No. 13 eats and drinks well, and although very lean, hardly anything but skin and bones, is lively and even playful. All other pigs are doing well.

July 26.—No essential changes. Pig No. 12 cannot walk, but took some water when carried to the trough. All other pigs doing well.

July 27.—Pig No. 12 dead at noon (for morbid changes see account of *post mortem* examination No. 11). No changes visible in any of the other pigs.

At this date my experiments became interrupted by sickness, and my experimental pigs, Nos. 1 A, 1 B, 2, 3, 9, 6, 7, 8 A, 8 B, and 13, were taken care of by Mr. Seymour, a student of the Illinois Industrial University, till August 4, and after that date by Mr. Lawrence, head farmer of the same University. According to Mr. Seymour none of the pigs showed any symptoms of active disease on August 4; so it must be supposed that the inoculation of pigs Nos. 1 A, 2, and 3, made July 20, was not followed by any new attack. In the afternoon of August 4, a very hot day, the pigs, with the exception of No. 13, were removed from the experimental pig-pen to the University farm. Pigs Nos. 6 and 7, two large sows, both in good condition, but weak and very much damaged by swine plague—both of them had a severe attack, and I have reason to suppose that nearly half of the tissue of their lungs was degenerated (hepatized)—it seems have been roughly handled by Mr. Lawrence's hired man, who removed them; at any rate, one of the sows died the same day, and the other one next morning. A *post mortem* examination was not made.

Pig No. 13 was cared for by Mr. Leal during my sickness, and kept on his premises, where it was fed with kitchen offal and corn.

On August 21 I was able to resume my work, engaged new pigs, looked about for suitable material for inoculation, and made arrangements to have my experimental pig-pen moved away from the University grounds to a private lot belonging to Mr. Leal, who gave me permission to do so. The moving of the pig-pen had become necessary, because during my sickness the Veterinary Infirmary building, in which I had to get the water for my pigs, had been moved to another place, which deprived me of water.

August 23.—Bought four very nice and perfectly healthy Berkshire pigs, belonging to the same litter, about 3 months old, of Hon. J. R. Scott, of Champaign.

August 25.—Received my pigs from Mr. Scott, and, as my pig-pen had not yet been moved, put them temporarily in Mr. Leal's cow-shed. They were then numbered 14, 15, 16, and 17. After several fruitless attempts to obtain material, I visited diseased herds of swine on August 22, 23, and 24, but found the disease everywhere of such a mild character that

I did not deem it expedient to take any material for inoculation and other experimental purposes. I succeeded in getting material at Mr. Bailey's farm (*cf.* account of *post mortem* examination Nos. 12 and 13). Inoculated at 5 o'clock p. m., in the usual way and with material (lung-exudation) of Mr. Bailey's pig No. 1 (old experimental pig), No. 13, and new pigs Nos. 14, 15, and 16. Pig No. 17, the smallest of the lot, had escaped from the cow-shed, and was not inoculated.

August 26 and 27.—No reaction.

August 28.—Succeeded in getting the experimental pig-pen moved to Mr. Leal's grounds, and disposed the pigs as follows: No. 13 in pen No. 6, No. 14 in pen No. 3, No. 15 and No. 16 in pen No. 4, and No. 17, the one not inoculated, in pen No. 7. No change and no reaction in any of the pigs.

August 29.—Commenced carbolic acid treatment with pigs Nos. 15 and 16, and gave three times a day, each time about 9 or 10 drops of a 95 per cent. solution to the two pigs. Pigs Nos. 13 and 14 received no medicines. All pigs apparently healthy, except No. 13, which is yet thin, has not grown any, and is still suffering from the morbid changes left behind by its severe attack of swine plague in July. It has, however, a good appetite, and is lively and active.

August 30.—No changes.

August 31.—Received back from Mr. Lawrence the old experimental pigs Nos. 1 A, 1 B, 2, 3, 9, 8 A, and 8 B. Nos. 6 and 7 had died on his hands on August 4, 5, respectively, as mentioned before. All pigs are doing well, but have grown very little, if any. No. 9 is still coughing occasionally, and suffering from the morbid changes left behind by its continued attack of swine plague. It is small and runty. After a very droughty season of several weeks' duration the first rain occurred to-day.

September 1.—All pigs doing well; heard Nos. 14 and 15 cough. It is raining.

September 2.—More rain. No change observable in the pigs.

September 3.—Very big rain. Pigs Nos. 14 and 13 do not seem to have as good appetite as usual—do not eat much. All other pigs are well.

September 4.—No change in any of the pigs.

September 5.—Heavy dew in the morning. None of the pigs show any plain symptoms of active disease; No. 14, though, does not eat well—eats about half a meal.

September 6 and 7.—No essential change.

September 8.—Pigs all right, except No. 14, which has poor appetite, and is not as lively as the others. It was at first slightly the largest and heaviest, but is not now.

September 9.—No essential change. The weather is cold and clear. Carbolic acid treatment of pigs Nos. 15 and 16, which are doing well in every respect, and always hungry, is discontinued.

September 10.—All pigs doing well, except No. 14, which every day eats some, but has a very unsatisfactory appetite, and is not near as active and lively as any of the others of the same litter. It is somewhat emaciated, and is now the smallest of the young pigs. No. 13 is active and has good appetite, but on account of the old morbid changes does not grow and improve in flesh. Found a small abscess on the right ear of pig No. 13, at the point at which the inoculation was made. The abscess—about as large as a small hazel-nut—contained thick, whitish matter. Pigs Nos. 13 and 14 cough occasionally.

September 18.—Not being able to obtain suitable material for inoculation and other experimental purposes in the neighborhood of Cham-

paign, I went to Effingham county, where swine plague was reported to be existing in a malignant form, and obtained some at I. Martin's place, near Mason (see *post-mortem* examination No. 14), and inoculated, on

September 19, Pigs Nos. 1 A, 1 B, 2, 3, 8 A, 8 B, 9, 13, 14, 15, and 16. Pig No. 17 was not inoculated. Performed the operations in the following manner: The tip of the pig's ear was taken in the left hand, and the point of a narrow-bladed knife, pointing toward the root of the ear, was inserted about half an inch deep, between the external skin and the cartilage of the ear, so as to form a small pocket. The knife withdrawn, a pipette, containing lung-exudation, was inserted in the pocket, the latter a little deepened by slight pressure upon the pipette, and a few drops of exudation dropped in by withdrawing the pipette. Commenced again at noon to give three times a day, each time about 9 or 10 drops of carbolic acid to pigs Nos. 15 and 16. The other pigs do not receive any medicine. No. 14 has very poor appetite, and is thin in the flanks and somewhat emaciated, yet eats a little at every meal, and, though evidently diseased, does not seem to be very sick.

September 20.—No change.

September 21 to 30.—No essential change in any of the pigs. All the older pigs especially do not seem to react in the least upon the inoculation. Pigs Nos. 14, 15, and 16, but particularly the first (No. 14), show somewhat diminished appetite. No. 14 has considerably emaciated, and is thin, but No. 15 and 16 are in very good condition and have not lost any flesh; they are as round and chubby as before, but have not grown much. The carbolic acid treatment was continued till September 30, at which date it was stopped.

October 1 to 12.—No change. All pigs are doing well, and none of them show any symptoms indicating the existence of acute disease.

October 13.—Again had to go to Effingham county for fresh material, and obtained some at the farm of Mr. Munday, who lives between Effingham and Watson (*cf.* account of *post-mortem* examination No. 15), and inoculated, on arriving at my experimental station at 4 o'clock p. m., pigs Nos. 13, 14, 15, 16, and 17 in the old manner, by means of a small inoculation needle. No. 17 had never been inoculated before.

October 14.—Fed the lungs, some lymphatic glands, and other tissues of Mr. Munday's pig, to pigs Nos. 1 A, 1 B, 2, 3, 8 A, 8 B, and 9.

November 3.—As none of the experimental pigs have shown any symptoms of active disease, I concluded to obtain fresh material from some other place, and went to Oquawka, Henderson county, Illinois, where, according to information received, swine plague was prevailing in a malignant form.

November 4, 5, and 6.—Visited several herds, and finally procured material at Mr. Beaty's farm (*cf.* account of *post-mortem* examination No. 16), on November 6. Starting for Champaign, or rather Urbana, immediately, I arrived there in the night.

November 7.—Inoculated in the usual manner pigs Nos. 13, 14, 15, 16, and 17, giving each pig four punctures. The right lobe of the lungs and some other morbid tissues of Mr. Munday's pig were fed to the older experimental pigs, and the left lobe was photographed (see photograph, Plate III). Next day I had to leave for Chicago, and left the pigs under the superintendence of my friend, Prof. F. W. Prentice, M. D., of the Illinois Industrial University. On November 17 I received notice of one of the pigs being sick, and went to Champaign on November 20, when I found pig No. 17 coughing, short of breath—each respiration causing a slight pumping motion of the flanks—and shivering. Pig No. 13 had died. This pig, as has been related, had a severe attack

of swine plague in July, and since that time had been inoculated four times (August 25, September 19, October 13, and November 7) without effect, but the morbid changes left behind by the first attack caused it to be very weak, and evidently interfered with the process of nutrition. The pig remained poor and did not grow. By the very cold weather of the last few days one of its feet, it seems, became frozen, and its pen-mate, pig No. 14 (it must be mentioned that pig No. 13 had to give up its pen to one of the older pigs, when the latter was returned by Mr. Lawrence, and was put together with No. 14), though a younger pig, but heavier and stronger, probably attacked and wounded the frozen foot. The frost did the rest. On the morning of the 18th of November pig No. 13 was found dead, frozen stiff, and the toes of one foot partially eaten off. The *post-mortem* examination, which was made November 20, was very difficult on account of the frozen condition of the carcass. The morbid changes found consisted, besides considerable swelling, of congestion and inflammation in one foot and leg, and other effects of freezing, exclusively of such as were left behind by the attack of swine plague in July, and were as follows:

In the chest evidences of old hepatization in both lobes of the lungs, extending in the right lobe to about one-fifth or one-sixth, and in the left one to about one-third of the whole lung tissue, and some serum in the chest and in the pericardium. In the abdominal cavity considerable enlargement of the liver, and in the interior of that organ in several places cavities (dilatations) in the hepatic ducts. These dilatations presented themselves as roundish and oval cavities of the size of a hazelnut, and, it must be presumed, have been caused and been occupied by worms (*cf. post-mortem* examination of two of the mates of this pig—experimental pigs Nos. 10 and 12).

All other experimental pigs appeared to be healthy. Nos. 1 A, 1 B, 2, 3, 8 A, 8 B, and 9, being of no more use as experimental pigs, were sold on November 20, and taken away on November 24.

Visited my experimental pigs again on December 1, and found pig No. 17 very thin, though not very much emaciated, and yet ailing; No. 14 was still poor, and Nos. 15 and 16 all right in every respect.

SUMMARY.—PIG NO. 1 A.

April 12.—Received a few drops of dried blood (of Mr. Dillon's pig) in its water for drinking.

May 3.—Inoculated with swine plague schizophytæ, cultivated in albumen.

July 20.—Inoculated with lung-exudation.

September 19.—Inoculated with lung-exudation.

October 14.—Fed with morbid tissues.

November 7.—Fed with morbid tissues. (This pig never showed any *plain* symptoms of swine plague, and it is doubtful whether it had a slight attack in April or not.)

PIG NO. 1 B.

April 12.—Received, together with 1 A, a few drops of dried blood (of Dillon's pig) in its water for drinking.

April 18.—Showed first symptoms of a mild attack of swine plague, from which it soon recovered.

May 3.—Inoculated with swine plague, schizophytæ cultivated in albumen.

September 19.—Inoculated with lung exudation.

October 14.—Fed with morbid tissues.

November 7.—Fed with morbid tissues.

PIG NO. 2 A (afterwards No. 2).

April 14.—Inoculated with swine-plague schizophytæ, cultivated in fresh milk.

April 24.—First symptoms of a mild attack, from which it soon recovered.

May 1.—Inoculated with lung-exudation.

May 7-21.—Treated with carbolic acid.

May 24.—Inoculated with lung-exudation.
May 24 *to June* 8.—Treated with carbolic acid.
June 16.—Inoculated with lung-exudation.
July 20.—Inoculated with lung-exudation.
September 19.—Inoculated with lung-exudation.
October 14.—Fed with morbid tissues.
November 7.—Fed with morbid tissues.

PIG NO. 2 B (afterwards No. 9).

April 14.—Inoculated with swine-plague schizophytæ, cultivated in water.
April 24.—First symptoms of a mild attack of swine plague.
May 1-21.—Treated with carbolic acid.
May 3.—Transferred to pen No. 5, in which pig No. 5 had died, and thus exposed to infection.
May 7.—Increased symptoms of disease.
May 24.—Inoculated with lung-exudation.
May 31.—Increased symptoms of swine plague; the disease assumes a chronic form.
June 16.—Inoculated with lung-exudation.
September 19.—Inoculated with lung-exudation.
October 14.—Fed with morbid tissues.
November 7.—Fed with morbid tissues. (This pig never fully recovered, but had no plain relapse after June 1.)

PIG NO. 3.

May 1.—Inoculated with lung-exudation.
May 1-21.—Treated with iodine-solution.
May 24.—Inoculated with lung-exudation.
June 16.—Inoculated with lung-exudation.
July 30.—Inoculated with lung-exudation.
September 19.—Inoculated with lung-exudation.
October 14.—Fed with morbid tissues.
November 7.—Fed with morbid tissues. (Pig never showed any plain symptoms of swine plague.)

PIG NO. 4.

April 7.—Inoculated with lung-exudation.
April 12.—First plain symptoms of swine plague.
April 24.—Death.

PIG NO. 5.

April 7.—Inoculated with lung-exudation.
April 11.—First plain symptoms of swine plague.
April 30.—Death.

PIG NO. 6.

April 29.—First plain symptoms of swine plague.
May 24.—Inoculated with lung-exudation.
June 16.—Inoculated with lung-exudation.
August 4.—Death from over-exertion in hot weather.

PIG NO. 7.

April 12, 15, 19, 22.—Fed with swine-plague schizophytæ, cultivated in albumen.
April 25.—First plain symptoms of swine plague.
May 24.—Inoculated with lung-exudation.
June 16.—Inoculated with lung-exudation.
August 5.—Death from over-exertion in hot weather.

PIG NO. 8 A and PIG NO. 8 B.

May 24.—Inoculated with lung-exudation.
May 24 *to June* 8.—Treated with benzoate of soda.
June 16.—Inoculated with lung-exudation.
September 19.—Inoculated with lung-exudation.
October 14.—Fed with infectious material (morbid tissue).
November 7.—Fed with morbid tissue.

PIG NO. 10.

June 16.—Inoculated with lung-exudation.
June 21.—First plain symptoms of swine plague.
July 24.—Death.

PIG NO. 11.

June 16.—Inoculated with lung-exudation.
June 21.—First plain symptoms of swine plague.
June 25.—Commenced treatment with carbolic acid.
July 20.—Death.

PIG NO. 12.

June 16.—Inoculated with lung-exudation.
June 21.—First plain symptoms of swine plague.
June 25.—Treatment with carbolic acid commenced.
July 27.—Death.

PIG NO. 13.

June 24.—First plain symptoms of swine plague.
June 25.—Treatment with carbolic acid commenced.
August 25.—Inoculated with lung-exudation.
September 19.—Inoculated with lung-exudation.
October 13.—Inoculated with lung-exudation.
November 7.—Inoculated with lung-exudation.
November 18.—Death caused by frost.

PIG NO. 14.

August 25.—Inoculated with lung-exudation.
September 8.—First symptoms of a mild attack of swine plague.
September 19.—Inoculated with lung-exudation.
October 13.—Inoculated with lung-exudation.
November 7.—Inoculated with lung-exudation.

PIG NO. 15 and PIG NO. 16.

August 25.—Inoculated with lung-exudation.
August 29 *to September* 9.—Carbolic-acid treatment.
September 19.—Inoculated with lung-exudation.
September 19–30.—Carbolic-acid treatment.
October 13.—Inoculated with lung-exudation.
November 7.—Inoculated with lung-exudation. (The two pigs never exhibited any plain symptoms of swine plague.)

PIG NO. 17.

October 13.—Inoculated with lung-exudation.
November 7.—Inoculated with lung-exudation.
November 20.—Plain symptoms, but probably not the first, of a mild attack of swine plague.

RESULTS OF EXPERIMENTS.

The results of these experiments are in perfect accord with my former observations, and do not show that swine plague is or will be communicated through the whole (not lesioned) skin, or through the uninjured respiratory mucous membranes of a healthy animal, even if it is surrounded by and has to breathe the same atmosphere in which an animal diseased with swine plague is breathing. As early as April 12 I had two genuine and malignant cases of swine plague (both had a fatal termination) in my experimental pig-pen in which all pigs, eleven in number on that date, were under one roof, separated only by rough board partitions, none too tight, and not more than 3 feet 10 inches high. Moreover, I inoculated first those pigs which occupied the two south pens, Nos. 4 and 5, knowing that in the spring and summer more wind must be expected from the south and from the southwest than from any other direction. The effluvia from the sick pigs, therefore, was driven almost constantly into the other pens. Afterwards pigs Nos. 4 and 5 died, and both pens were again occupied by two very sick pigs; pen No. 4 by pig No. 10, which died after about a month's illness, and pen No. 5 by pig No. 9, in which the disease became chronic. Notwithstanding all this,

none of the pigs not inoculated or otherwise purposely infected and *free from external sores or wounds* became infected. It is true pig No. 6 contracted swine plague before it had been inoculated by occupying pen No. 6, which joins No. 5, but pig No. 6 had a sore nose; it had been ringed, and external sores, as has before been shown, are liable to attract and absorb the swine-plague schizophytæ, which may happen to be floating in the air, even if the diseased animals from which they come are quite a distance off. Pig No. 13, too, became infected by association with pigs Nos. 10, 11, and 12 (all three inoculated and diseased) in the same pen, but all four pigs had to eat and to drink out of the same trough, and all, pig-fashion, not only soiled their noses with their own excretions and those of their companions, but also put their dirty feet into the trough at every meal. Hence, it is more than probable that pig No. 13 consumed food and water contaminated with an abundance of swine-plague schizophytæ, voided or discharged with the excrements and urine of the inoculated and diseased pigs, and may be also with their saliva and mucus discharges from the nose. The case of pig No. 13 proves also another thing, viz., that swine plague can be communicated, and that swine-plague schizophytæ are already discharged during the stage of colonization (period of incubation), or before plain morbid symptoms can be observed, because, as appears from the accounts of pigs Nos. 10, 11, 12, and 13, the latter must have become infected before the others showed any plain symptoms of disease, or the stage of colonization must have been an uncommonly short one in pig No. 13. All four pigs, as has been mentioned, were raised by the Hon. J. R. Scott, president of the Illinois State Board of Agriculture, and the rest of the litter, five pigs, are yet, at any rate a few weeks ago, in his possession, and have never been ailing. Neither has Mr. Scott had any disease among his swine for over a year, and may be for over two years. So the animal cannot have been infected when I received it.

2. The value of carbolic acid and of other antiseptics as preventives of swine plague, if used in time, immediately after an infection has taken place, and before any morbid changes have developed, has been confirmed by the results of my experiments (*cf.* account of experimental pigs Nos. 2 A, 2 B, 3, 7, 8 *a*, 8 B, 15, and 16). It is true, Nos. 2 A and 2 B (the latter not fully) had recovered from a mild attack of swine plague, brought on by an inoculation with cultivated schizophytæ, when the second inoculation was made and the carbolic-acid treatment commenced with, and if such a mild attack is, in a majority of cases, sufficient to produce immunity, as seems to be the case, it is possible that pig No. 2 A might not have contracted the disease after the second inoculation if no carbolic acid had been used. Pig No. 2 B had not fully recovered. The morbid process was yet active, and morbid changes were existing when subjected to the carbolic-acid treatment, and the carbolic acid, it seems, had the effect of checking the impetus which the morbid process received when the animal was transferred to the thoroughly infected pen No. 5, and compelled to eat the food left there, which had been contaminated by pig No. 5. Pig No. 2 B was thus exposed to a very severe infection, which, due undoubtedly to the carbolic acid treatment, had very little effect, although the animal evidently had not lost its predisposition, because, after a third far less severe and lasting infection inoculation on May 24, an exacerbation became visible May 31. Pig No. 7 had recovered from a rather severe attack, when it was inoculated with lung-exudation on May 24, and subjected to the carbolic-acid treatment; it is therefore possible, and even probable, that the inoculation, on account of the previous attack, would have remained

ineffective, if no carbolic acid had been used. The same, after another inoculation, made June 16, had its appetite disturbed, and may have had a very slight attack, but the latter is doubtful. There exists, however, no uncertainty in regard to pigs Nos. 15 and 16. They were treated with carbolic acid soon after the first inoculation, and neither the first nor any of the three subsequent inoculations (*cf.* account of those pigs) produced any morbid changes. I saw those pigs again on December 1, and found them thrifty, healthy, and in a good condition, which proves that they never suffered from swine plague, because every attack, no matter how mild, always leaves some traces behind, and more or less retards the growth and development of the animal. Every other one of the experimental pigs that contracted the disease and recovered, even pig No. 1 A, of which it is not certain whether it had a mild attack or not, but probably had after the first infection, has become more or less stunted, and is not near as thrifty as a healthy pig.

The carbolic-acid treatment, however, is of not much use it not commenced with before plain symptoms of swine plague have made their appearance, or, what is the same, before serious morbid changes have been produced (*cf.* account of experimental pigs Nos. 11, 12, and 13); because the carbolic acid cannot repair those morbid changes which, in many cases at least, very soon develop sufficiently to make a continuation of life impossible, or to cause death by exhaustion, even if the activity of the morbid process is interrupted, or its cause removed or neutralized before the disease has reached its acme or greatest violence (*cf.* account of *post-mortem* examination No. 9 of pig No. 11). It must be mentioned, however, that pigs Nos. 11, 12, and 13 were very irregular in drinking, and took but very little food while sick, therefore they did not regularly consume their allotted doses of carbolic acid, and on several days took next to nothing, or not anything at all.

Benzoate of soda was tried, and proved to be a good preventive (*cf.* account of pigs Nos. 8 A and 8 B), but its high price forbids its use in a large herd of swine.

The iodine treatment of pig No. 3 has also given very good results, but experimenting with iodine was not continued, because it was found that a continued use of iodine interferes with the organic change of matter, decreases the secretions and excretions, and seriously diminishes the appetite and the desire to drink; consequently a continued use of iodine, it must be supposed, will materially reduce the growth and thriftiness of the animal.

More experiments with preventives might have been made, and those made might have been repeated, but to do so would have required a large number of experimental pigs, and besides that, it was nearly always, and particularly in the latter part of the season, very difficult to procure reliable material (from a malignant case) when wanted. Those places where the disease, according to the best information obtainable, was existing in a malignant form—the central part of Northern Iowa, for instance—were too far off, and to move the experimental station would not only have been expensive, but would also have caused much loss of time. Besides that, the first symptoms of the disease are well known by nearly every one, and wherever it makes its appearance the farmers, as a rule, hasten to sell off every pig they have on the place; hence a great scarcity of reliable material even in badly infected districts.

3. The results of my experiments corroborate the correctness of my former observations, that a healthy pig, one that never had swine plague, will almost invariably contract that disease if inoculated with the lung-exudation of a pig affected with swine plague, provided no measures of

prevention are applied. I say "almost" invariably, because experimental pig No. 17 apparently makes an exception; it did not take the disease after the first inoculation with material from Mr. Munday's pig, and it seems that several circumstances combined to make that inoculation ineffective. In the first place, pig No. 17 seemed to possess an uncommon resistibility, or very little predisposition, because it took the disease only in a very mild form after the second inoculation with material from Mr. Beaty's pig. Secondly, the material used for the first inoculation, although the best I was able to obtain, was from a pig which had a comparatively mild attack, had been ailing for some time, had passed the height of the disease, had regained more or less appetite, and was already recovering, or, at least, was better than it had been. The material (lung-exudation), therefore, may have lacked sufficient vigor, although swine-plague schizophytæ were present. Other schizophytæ, *bacteria termo* and *bacteria lineola*, however, also made their appearance in an uncommonly short time (see drawings), and although not found in the lung-exudation when the inoculation was made, it is not certain, judging by later developments, that their germs did not exist, and it is not impossible that the same, if existing, may have interfered with a proper development of the swine-plague schizmoycetes. In explanation it must be stated that I had a new, large, and perfectly clean salt-mouthed bottle with a new rubber stopper when I went to Mr. Munday's place, but when ready to make the *post-mortem* examination, I found that the bottle, which was in a satchel, had become broken in the wagon on the rough roads. I was therefore obliged to procure from Mr. Munday another bottle for the morbid tissues I wished to take with me, and obtained one which had been used for preserves, and, although carefully rinsed with water, may have contained, hidden in the cork perhaps, some *termo* and *lineola* germs.

The results of my experiments show further that an attack of swine plague of which the animal recovers produces immunity from the effect of subsequent infections in most cases, but not in all. Some pigs will contract the disease a second and even a third time, especially if inoculated, or exposed to an infection before they have fully recovered (*cf.* account of experimental pig No. 2 B, afterwards No. 9), but the second or third affection, it seems, is always a comparatively mild one, and does not become fatal. Hence the first affection with swine plague gives the animal, after its recovery, always some protection against a subsequent infection by mitigating the morbid process, and in many, perhaps a large majority of cases, produces an almost complete immunity. I say "an *almost* complete immunity," because a pig that has recovered from an attack of swine plague will usually show some slight reaction if again inoculated or otherwise infected, although no morbid changes may be produced (*cf.* the summary of experiments which shows how often, and at what times each one of the experimental pigs was inoculated and fed with infectious material, and that only one of the pigs which survived the first attack contracted the disease oftener than once, and each time before it had fully recovered).

4. The two inoculations with cultivated material, swine plague schizophytæ cultivated in milk and in water respectively, proved to be effective, and, the same as in former cases, were followed by a mild attack. Such, therefore, seems to be the rule, and as there can be no doubt that an affection with swine plague, resulting from an inoculation with cultivated material, will afford just as much protection against subsequent infection as any other attack of swine plague caused by an inoculation with material directly from the body of a sick hog, or by natural infec-

tion; inoculations with cultivated material might be made use of for the purpose of lessening the losses caused by the plague. But whether such inoculations can be recommended from a practical standpoint is quite another question. If a large herd of swine is inoculated with cultivated swine plague schizophytæ, cultivated, for instance, in milk, it may be expected that most of the animals will take the disease in a mild form, and that the direct losses by death will be very few; but on the other hand it is also possible that such a simultaneous outbreak of swine plague in a whole herd, as would result from such a wholesale inoculation, no matter how mild the cases originally may be, will cause a considerable accumulation of the infectious principle (the swine-plague schizophytæ, and their germs) within the herd and on the premises; and such being the case, it may be expected that many animals, while affected, will get a sufficient influx of the swine plague schizophytæ, with their food, their water for drinking, and sores or wounds that may happen to exist, to make their case a protracted and malignant, or even fatal one. Further, experience teaches that nearly every pig that recovers from an attack of the plague, even if the same is very mild, and only the result of an inoculation with cultivated material, will become a runt or be stunted in its growth, and will never pay its owner a full price for the food it consumes. The lymphatic glands, or at least a great many of them, it seems, undergo more or less permanent changes, which disqualify them to perform their functions as fully as those of a perfectly healthy animal, and this alone is sufficient to account for the disordered nutrition, even if the morbid changes, invariably produced in the lungs, are comparatively unimportant.

6. Swine plague in other animals.

By last year's investigation (*cf.* special report No. 22) it was found that swine plague can, under favorable circumstances, be communicated to other mammals. Two years ago (*cf.* special report No. 12) I tried to infect chickens with the disease by feeding them with morbid tissues of a dead pig, but did not succeed. Last summer I repeated the same experiment on a larger scale, and repeatedly fed large quantities of very infectious morbid tissues, such as lungs, liver, heart, lymphatic glands, intestines, blood, pieces of meat, &c., to quite a number of chickens; besides this the chickens consumed considerable corn refused and made dirty by the experimental pigs, but not one of them contracted the disease or exhibited any symptom of disease resembling swine plague. So it may be safely concluded that chickens possess very little, if any, predisposition to the disease, and are not likely to become infected; further, that the latter and so-called chicken cholera are entirely different diseases, which have no causal connection whatever to each other.

7. The infectious principle.

To determine the true nature, and to learn as much as possible about the characteristics and peculiarities of the infectious principle, the swine-plague schizophytæ has been one of my principal endeavors, because any advance gained in that direction I considered as of the greatest importance, not only to science, but also for practical purposes. If we want to fight and to conquer an enemy, we must first know the same; consequently, if we want to fight swine plague we must know as much as possible about its nature and cause. I have, therefore, endeavored to procure the best objectives obtainable. Those principally used are a $\frac{1}{10}$ homogeneous immersion of Tolles, and a $\frac{1}{15}$ also homogeneous immer-

sion, made a month ago specially for my work by the same renowned maker.

As to a proper generic name of the swine-plague schizophytæ, I am at at loss. The principal authorities on such low forms of life, Cohn, Klebs, and others, who have attempted a classification, do not agree as to where the generic lines ought to be drawn. At any rate, the schizophytæ of swine plague do not fit into any of the genera proposed. They are not bacteria, because the single cells are round; they can hardly be considered as micrococci, because in their developed form they are bispherical; and they cannot be classed among the bacilli, on account of their forming zoöglœa masses. I have, therefore, preferred to use that name which, without any serious contradiction, is given to the whole family, viz: schizophytæ, or the older but less appropriate name, introduced by Naegeli, schizomycetes.

As further proof that the swine-plague schizophytæ and nothing else constitute the infectious principle of swine plague, I can offer the following:

1. Inoculations with swine-plague schizophytæ cultivated in water and in fresh milk (*cf.* account of experimental pigs Nos. 2 A and 2 B), though productive only of a mild attack, proved to be effective, and feeding swine-plague schizophytæ cultivated in albumen to a healthy pig produced in due time a comparatively severe attack of swine plague (*cf.* account of experimental pig No. 7).

2. Open sores, wounds, and scratches attract and absorb the infectious principle if floating in the air (*cf.* account of experimental pig No. 7, and of Mr. Beaty's herd, visited in November).

3. Certain antiseptics or medicines which possess the property of being either directly poisonous to low forms of organic life (schizophytæ), or destructive to those conditions which are necessary to the existence, growth, and development of those minute forms, and among them particularly carbolic acid, iodine, hyposulphite of soda, benzoate of soda, &c., have proved almost sure preventives. As the chemical properties and affinities of those antiseptics are very dissimilar and entirely different, but as they all possess properties which are inimical and more or less destructive to the growth and development of schizophytæ (micrococci, bacteria, and bacilli), it cannot very well be claimed that those antiseptics have proved to be efficient preventives, because the same have decomposed or neutralized a chemical virus and not poisoned or prevented from developing something endowed with vitality and power of propagation.

4. The condition of the blood which, with the exception of containing schizophytæ mostly in shape of micrococci, is never essentially changed or presents anything abnormal until the morbid changes in the affected parts or tissues have become very extensive, and by interfering with the processes of nuitrition and respiration have produced an abnormal composition of the blood. Consequently it cannot be a chemical virus or mysterious chemical something, which one would suppose would first act upon the blood. Further, the morbid changes in the lungs, in the skin, and in other parts, if closely examined, will show that they are the results primarily, at least, of obstructions in the capillaries, and as nothing else capable of causing obstruction in the capillaries has been found than the schizophytæ and their zoöglœa masses, it cannot be presumed that the latter, but something that is invisible, absent, or spirit-like, and never yet shown, has caused the mischief and brought about the obstructions. Besides, the zoöglœa masses or coccoglia are never absent in the affected tissues.

5. The opponents of the so-called "germ theory" of diseases, well knowing that a complete separation of the schizophytæ (micrococci, bacteria, or bacilli, as the case may be) from the animal tissues and fluids is impossible, demand absolute proof, without offering any evidence whatever in support of their own "theories," or even demonstrating the existence of anything akin to what they claim constitutes the cause and infectious principle of infectious diseases. If conclusions may be drawn from an analogy between infectious diseases of plants and animals, Prof. T. J. Burrill, of the Illinois Industrial University, Champaign, Ill., being more favored by the nature of the objects of his investigations—apple-trees, pear trees, &c.—has furnished almost absolute proof in support of the so called "germ theory," when he found and proved that the so-called "blight" of apple and pear trees and the so-called "yellows" of peaches are caused and spread by schizophytæ somewhat similar in size and superficial appearance, but not identical, to those schizophytæ which produce swine plague (*cf.* the transactions of the meeting of the American Association for the Advancement of Science in Boston, 1880).

6. If the infectious principle were a chemical something—a chemical poison or virus—one would suppose that its action would be the same under all circumstances, and that the malignancy of the disease and the time required for its development (the so-called period of incubation) would not be subject to changes dependent upon the season of the year and upon other partially unknown external influences, but such is the case. In the same localities, in the same yards and pig-pens, and in the same breeds of swine in which the disease was exceedingly malignant in 1878, it was, as a rule, very mild in the latter part of 1879 and 1880, while at other places where it did not exist in 1878 it was rather more malignant in 1880. As what has just been stated are undisputable facts, nothing but what is able to grow and develop is subject to changes and acquires vigor and propagates rapidly under favorable and is weakened and multiplied slowly under unfavorable circumstances—in other words, nothing but what is endowed with life—can constitute the cause and the infectious principle of the disease.

7. If the cause and infectious principle of the plague consisted in some chemical poison, the fact that the first attack, if not fatal, produces, as a rule, immunity from subsequent infection, and that some animals possess more predisposition than others, or that an animal while continually under the influence of the infectious principle can recover, can never be explained; but the whole case presents an entirely different aspect, and admits of explanation, if low forms of organic life (schizophytæ) constitute the cause and the infectious principle, forms which, by developing and multiplying, finally destroy the conditions necessary to their own existence in the animal body (*cf.* an article entitled "The Destruction of Germs" in the Popular Science Monthly, communicated in extract in R. Hitchcock's Monthly Microscopical Journal for November, 1880).

Finally, with very superior objectives and a fair ability to handle the microscope and to prepare objects for examination, I have never been able to find any schizophytæ in the blood and tissues of other healthy animals identical to those of swine plague. In my last drawings, those in which the swine-plague schizophytæ are represented, as seen with the $\frac{1}{15}$ homogeneous immersion objective of Tolles, and the Beck No. 2 eye-piece—amplification a little over 1,500 diameters—the difference between the same and other bacteria will be apparent at the first glance. If lower powers, objectives of less superior and accurate construction

SWINE PLAGUE.

Investigations by Dr. H. J. Detmers. Plate I.

Lungs of Experimental Pig No. 4.

A. Hoen & Co. Lithocaustic, Baltimore

SWINE PLAGUE.

Investigations by Dr. H. J. Detmers. Plate II.

Ulcerous tumors in colon of Mr. Carson's pig.
(Post mortem acc. No. 7.)

A. Hoen & Co. Lithocaustic. Baltimore

SWINE PLAGUE.

Investigations by Dr. H. J. Detmers.

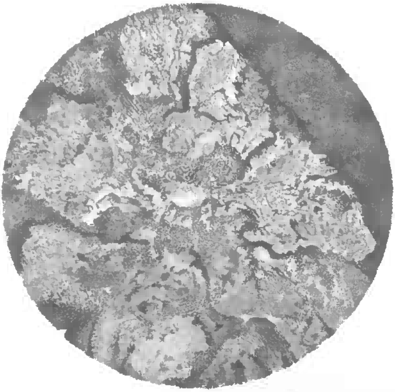
Plate III.

Left lobe of Lung of Mr. Beaty's Pig.

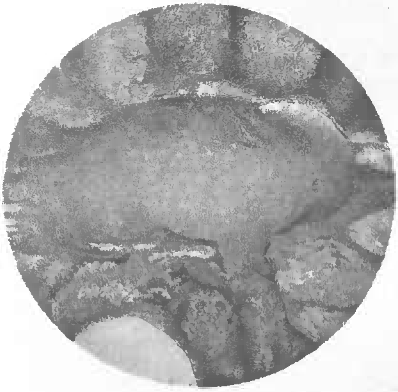
A Hoen & Co. Lithocaustic, Baltimore

SWINE PLAGUE.

Investigations by Dr. H. J. Detmers. Plate IV.



No 1 a Part of clogged blood vessel and hepatized lung tissue of Lung of Experimental pig No.4. ¼ in. objective. x 100.



No.1 b Extravasation of blood and clogged blood vessel in hepatized Lung of Experimental pig. No.4. ¼ in. objective. x 100.

A.Hoen & Co Lithocaustic Baltimore

SWINE PLAGUE.

Investigations by Dr. H. J. Detmers. Plate V.

No. 3 Slough in skin of lip of pig diseased with swine plague. 1 in. Objective. x 22.

No. 4 Partially diseased lung (incipient hepatization, or exudation unorganized and still fluid) of young pig. ¼ in. objective. x 100.

A. Hoen & Co. Lithocaustic Baltimore

SWINE PLAGUE.

Investigations by Dr. H. J. Detmers. Plate VI.

No. 5 a Strongylus paradoxus. Tail end of female depositing eggs. 1/4 in. objective. x 100.

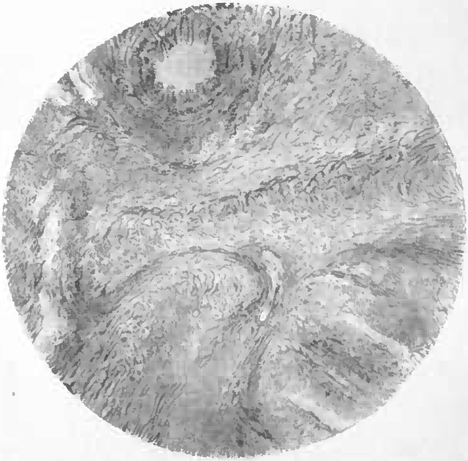
No. 5 b Head of Strongylus paradoxus, or lung worm. 1/4 in. Objective. x 100.

A. Hoen & Co. Lithocaustic Baltimore

SWINE PLAGUE.

Investigations by Dr. H. J. Detmers. Plate VII.

No. 6a Hepatized lung tissue of young pig, showing almost intact bronchial tubes. 1 inch. objective X 22.

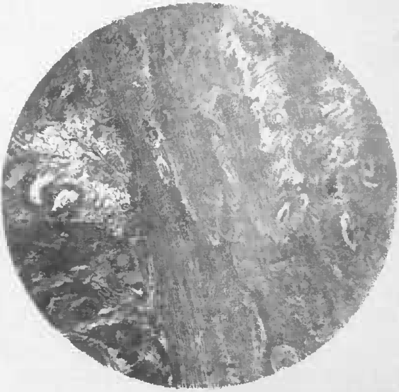


No. 6b One small and a portion of a larger bronchial tube, both almost normal in perfectly hepatized lung tissue of young pig. A portion of same field as No. 6a but more highly magnified, 1/4 in. objective X 100.

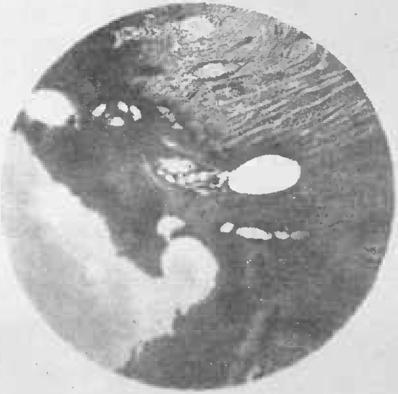
A. Hoen & Co. Lithocaustic Baltimore

SWINE PLAGUE.

Investigations by Dr. H. J. Detmers. Plate VIII.



No. 7ª Portion of diseased skin of Nose of pig. 1in. objective. x 22.

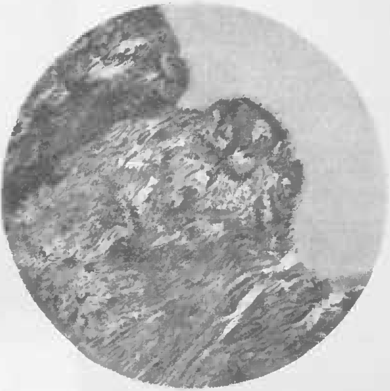


No. 7ᵇ Slough in skin of nose of pig. 1in. objective. x 22.

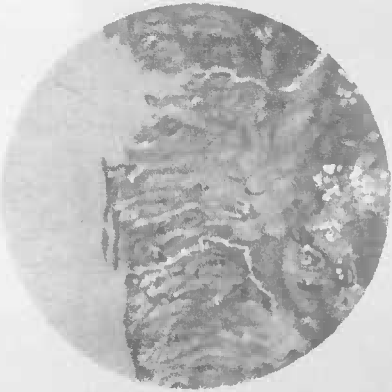
A. Hoen & Co. Lithocaustic, Baltimore

SWINE PLAGUE.

Investigations by Dr. H. J. Detmers. Plate IX.



No. 9a Ulcerous tumor of Cæcum. 1/4 in. objective. x 22.



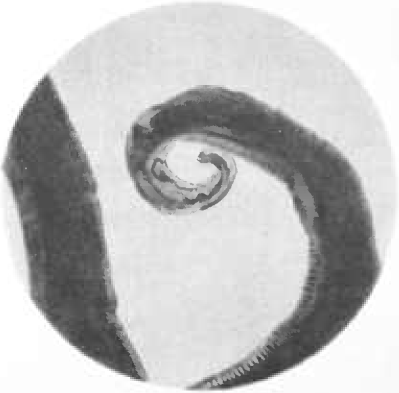
No. 9b Ulcerous tumor of Cæcum of J. Martin's pig. 1 in. objective. x 100.

A. Hoen & Co. Lithocaustic Baltimore

SWINE PLAGUE.

Investigations by Dr. H. J. Detmers. Plate X.

No. 10. Ulcerous tumor of colon. 1in. objective. x 20.



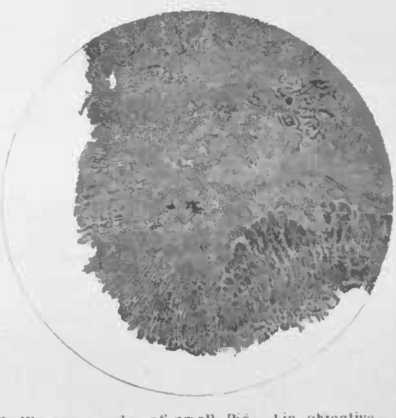
No. 11ª Tail of Trichocephalus crenatus. 1in. objective. x 22.

A. Hoen & Co. Lithocaustic, Baltimore

SWINE PLAGUE.

Investigations by Dr. H. J. Detmers. Plate XI.

No. 11b Head of Trichocephalus crenatus, 1 in. objective. x 22.



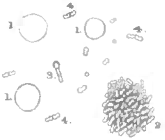
No. 13. Ulcerous colon of small Pig. 1 in. objective. X 22.

A. Hoen & Co. Lithocaustic Baltimore

SWINE PLAGUE.

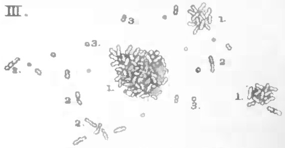
Microscopic Investigations by Dr. H. J. Detmers.

II.



Blood-Serum from the lungs of Dillon's pig No. 1.
1, 1, 1, Blood corpuscles.
2, Zoögloea-mass.
3, Helobacterium (lasting spore.)
4, 4, 4, Swine-plague Schizophytæ.
x 925. Objective: Tolle's 1/10 homog. im.
Time: 6, 4. 80.

III.



Albumen from a hen's egg; charged with infected water April, 12th
x 925. Objective: Tolle's 1/10.
Time: 17. 4. 80. 8 P.M. Champaign, Ill.
1, 1, 1, Zoögloea-masses.
2, 2, 2, 2, Rod shaped Schizophytæ of Swine-plague.
3, 3, 3, Swine-plague-micrococci.

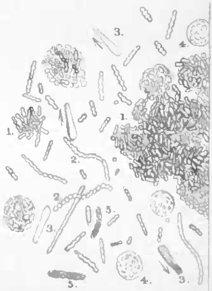
IV a.

Swine-Plague Schizophytæ as seen in the pulmonal exudation of Experimental Pig No. 5. Some of them more fully developed, and all lively moving. Exudation treated with Caustic Potash. Examined 26 hours after death; exudation free from any putrifaction and without smell.
x 925. Tolle's 1/10 homogeneous immersion and B Eyepiece.
I. V. 80. 9 P.M.

IV b.

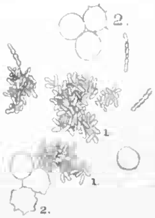
The same not treated with caustic potash. a, tumbling, and partially out of focus.

V a.



Swine-plague Schizophytæ in pulmonal exudation of Mr. Philippi's pig.
1, 1, Zoögloea-masses (part of)
2, 2, Chains of Swine-Plague-Schizophytæ.
4, Blood corpuscles.
3, 5, 5, Swift moving bacteria, just appearing.
x 925, Objective: Tolle's 1/10 homog. im.
Eyepiece Beck's No. 2 [illegible]

V b.



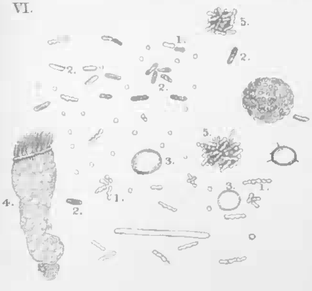
Swine-plague Schizophytæ in blood serum of same pig.
1, 1, Zoögloea masses.
2, 2, Blood corpuscles amplification and same objective as in V a.

[illegible]

SWINE PLAGUE.

Microscopic Investigations by Dr. H. J. Detmers.

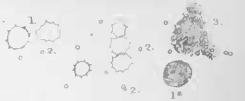
VI.



Pulmonal Exudation of Isaac Martin's pig. x 925. Objective: Tolle's 1/10 homogeneous immersion; Eyepiece: Beck's B. Time: 19.9.80.

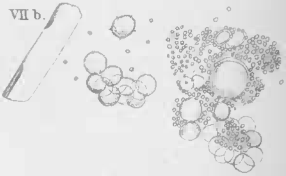
1.1.1. Swine-plague Schizophytæ;
2,2,2. Bacterium termo.
3,3,3. Blood corpuscles.
4, Ciliated epithelium.
5, Zoöglœa mass.

VII a.



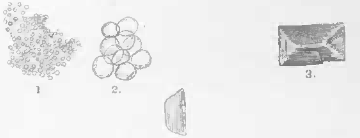
Fresh Pulmonal Exudation of Mr. Munday's pig, killed by bleeding at 9.30 A.M. 13.10.80.
x 925 Tolle's 1/10 homog. im. Objective. Beck's No. 2 Eyepiece.
1. 1. Blood corpuscles.
1a White Blood corpuscles.
2, 2, 2, Single and double Micrococci.
3, Zoöglœa mass 7 P.M. 13.10.80.

VII b.



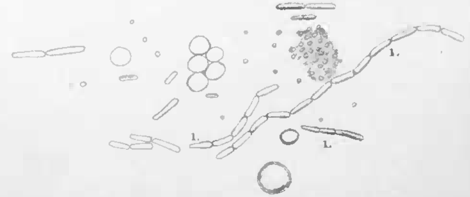
The same as above, but examined in day-light at 11, A.M. 14, 10, 80.

VII c.



Blood serum from Carotis of Munday's pig.
Examined 11, A.M. 14.10.80. x 925.
1, Zoöglœa mass.
2, Blood corpuscles.
3, Crystal.

VIII.



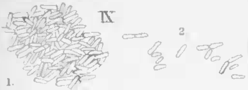
Pulmonal Exudation of Munday's Pig (slightly putrid.)
x 925. Examined at 7.30 P.M. 14.10.80.
1, 1, 1, Bacillus chains.

A. Hoen & Co Lithocaustic, Baltimore

SWINE PLAGUE.

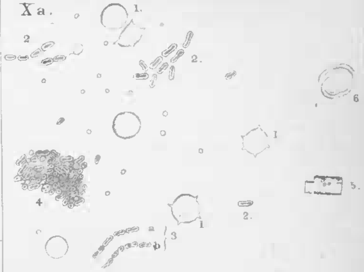
Microscopic Investigations by Dr. H. J. Detmers.

IX



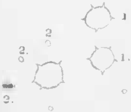
Bacterium termo in Blood serum from carotis (Munday's Pig) very putrid. ×925.
Examined at 8 P.M. 14. 10. 80.
1. Small portion of an extensive Zoögloea-mass, adhering to the coverglass.
2. Specimens of bacteria resting on the slide and moving.
No blood corpuscles.

Xa.



Pulmonal Exudation of Beaty's Pig.
Examined fresh Nov. 7th 3 P.M.
Objective: Tolle's homog. immersion 1/15
Ocular: Beck's No. 2;
Amplification: about 1500
1, 1, 1. Blood corpuscles.
2, 2, 2. Swine-Plague Schizophytæ.
3 a and b. The same. b. 5 minutes later than a.
4. Zoögloea mass.
5. Crystal.
6. White Blood corpuscle.

Xb.

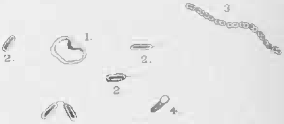


Blood of same animal examined at the same time with the same appliances and same amplification.
1, 1. Blood corpuscles.
2, 2, 2. Swine-Plague Micrococci.

Xc.

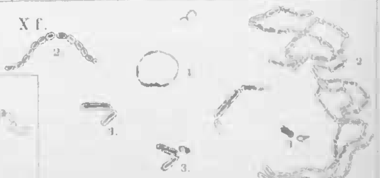
The same Pulmonal Exudation examined with the same Appliances one day later, Nov. 8th at 8 P.M.
1. Blood corpuscle of about 4.4 in diameter.
2. Swinging Bacterium attached to 3 by a slender, almost invisible chord: its length is 3.3
4. Just divided Micrococci.
5. Helobacteria.

Xe.



The same Pulmonal Exudation, examined Nov. 13th. Same Objective and same Eyepiece × about 1500.
1. Blood corpuscle, collapsing.
2, 2, 2. Bacterium termo is making its appearance.
3. A chain of Swine-Plague Schizophytæ.
4. Helobacterium.

Xf.



Blood serum of Mr. Beaty's pig × about 1500.
Objective: Tolle's 1/15 homogeneous im.
Eyepiece Beck's No. 2. Time Nov. 14.
1. Blood corpuscle, collapsing.
2, 2. Bacteria-chains.
3, 3, 3, rapitly moving and tumbling Bacteria.

Xd.

Swine-Plague Schizophytæ in the Lung-Exudation of Mr. Beaty's pig. Drawn from Nature × about 1500. Objective: Tolle's 1/15 homogeneous immersion Eyepiece Beck's No. 2
Nov. 12th D.

A. Hoen & Co. Lithocaustic Baltimore

and of lower angle of aperture, are used, those differences, I admit, can be seen only with difficulty or not at all.

The swine-plague schizophytæ present themselves in different shape and form. The simplest form, it seems, is that of a micrococcus, a small, round body (globule), which strongly refracts the light, of about 0.7^{mm} to 0.8^{mm} in diameter. It occurs in the blood and the morbid exudations in the tissues, &c., of the diseased swine, and is never absent, but is found in some cases and under some conditions in much larger numbers than in others. The second form is bispherical—the globular cell (micrococcus) has duplicated itself. The globular or spherical cell, or micrococcus, grows and becomes somewhat oval in shape, but becomes indented or contracted in the middle, and keeps on growing while the indentation becomes deeper, till its length is about twice its width and its shape bispherical. For some time, however, the bilateral indention does not effect a complete separation, a connection between the two spherical cells remains, sometimes only for a short time, and sometimes longer—may be, for hours. These bispherical schizophytæ are always more or less numerous, are either at rest or moving, and usually provided at one end with a flagellum, a post-flagellum, which, however, is so exceedingly fine that I have never seen it except with the $\frac{1}{15}$ homogeneous immersion objective of Tolles, and an amplification of over 1,500 diameters, and then only while the schizophytæ was moving (*cf.* drawings). These double micrococci, or bispherical schizophytæ, soon multiply under favorable conditions. The bilateral indentation becomes deeper, while at the same time the single cells commence to grow and assume a somewhat oval shape, and in both another bilateral indentation becomes visible. Meanwhile the separation in the middle becomes more perfect, and soon one bispherical cell has developed into two bispherical cells or micrococci, which are yet slightly connected, at any rate they remain together, although the separation appears to be perfect, as each cell presents its own outlines. The division thus goes on, and it often happens (see drawings) that a whole chain of such bispherical schizophytæ adhering endways to each other, comes into the field. If powers of 900 or 1,000 diameters are used, such a chain very often appears like a thin moniliform bacterium. Under higher powers the appearance is not dissimilar to that of a piece of a chain out of a watch. Sometimes the dividing process is a rapid one, and I have repeatedly observed that the number of bispherical schizophytæ contained in such a chain doubled in less than five minutes.

Thus it will be seen that the propagation is a rapid one. If circumstances are favorable, and especially if the temperature is not too low, these chains break up into smaller ones, consisting each of one, two, or more bispherical micrococci or schizophytæ, which, in separating from their neighbors, spin or draw out a very slender thread—a flagellum or a cilia. But before all these changes and this multiplying by fission take place the spherical and bispherical micrococci or schizophytæ—the bispherical, probably such as have developed from the spherical micrococci, and do not owe their existence to the fission process—form those clusters (zoöglœa masses or coccoglia), which obstruct the capillaries, and, according to my observations, constitute the immediate cause of the morbid process of swine plague. In these zoöglœa masses the spherical or single micrococci, and the bispherical schizophytæ are imbedded in and held together by a viscous substance, the glia, and the spherical or single micrococci undergo their first change, and develop into bispherical bodies, till the glia breaks or opens, when a great many bispherical schizophytæ, and also some of the

spherical bodies become free. The former, thus freed, very soon commence to multiply by fission, but as this process results in a production of bispherical, and not of spherical cells or micrococci, the latter must have another origin. In swine-plague material, for instance, in the blood and in the exudation from the lungs, if a day or two old, and sometimes while yet fresh, bacteria of a peculiar shape can be observed. They are rod-shaped, about as long, or perhaps a little longer than two bispherical schizophytæ connected endwise, but not moniliform, and have on one end, or in some cases toward the middle, a bright and light-refracting globule of fully as much, or a trifle more, diameter than the width of the bacterium, and surrounded by a substance, as a thin envelope, which apparently is of less density because less light-refracting. If this globule is situated at one end the bacterium presents the appearance of a short stick with a knot at one end (*cf.* drawing Xc. 5). Billroth calls this form a helobacterium and the globule a lasting spore (*Dauerspore*). This lasting spore, according to Billroth and Cohn, resists almost any degree of heat and cold, is very prolific, and produces a large number of germs, which develop into micrococci. As such helobacteria are sometimes found in swine-plague material (blood, exudations, &c.), while yet fresh, and almost always when a few days old, it appears probable that the same constitute another form of the swine-plague schizophytæ, develop from a bispherical cell produced by the fission process, and constitute the source of the spherical micrococci. I say it appears probable because I have seen the same cycle of changes complete itself in somewhat larger schizophytæ, belonging to the genus Bacillus and found in the blood of cattle which had died of Texas fever, but so far have not succeeded in watching and observing every one of those changes in the swine-plague schizophytæ, because the exceedingly small size of the latter requires for accurate observation a higher amplification than I was able to apply without loss of definition before I received, about a month ago, the new $\frac{1}{75}$ objective of Tolles.

If these helobacteria, which occur in the blood, exudation, &c., of pigs affected with swine plague, constitute a form of swine-plague schizophytæ, and are the lasting spores of the latter, as is very probably the case, their extraordinary tenacity of life, or great resistibility against adverse influences, probably explains the ability of the infectious principle of swine plague to remain effective for a whole year, if protected by adhering to, or by being imbedded in, a moist and porous substance, such as an old strawstack or other porous body of a similar character. Whether or not the swine-plague schizophytæ are able to multiply by any other means, or in any other manner than stated, I have not been able to observe. One observation, repeatedly made before, has found new confirmation, viz:

Wherever, or as soon, as *bacterium termo* makes its appearance, the swine-plague schizophytæ commence to disappear, and disappear in about the ratio in which the putrefaction bacteria increase in numbers. In blood kept in a vial the swine-plague schizophytæ cannot be found after the blood commences to exhibit a purplish color, or when the blood corpuscles are destroyed. Further, the swine-plague schizophytæ, although presenting the same general characteristics when cultivated in fluids foreign to the animal organism of a hog, show differences in so far as the same develop and multiply less rapidly and with less regularity, and show less uniformity or more difference as to size. It seems the cultivated schizophytæ are slower in their changes, and, therefore, probably less vigorous in producing disease; at any rate an inoculation with cultivated schizophytæ, although effective in producing swine

plague, is always followed by a comparatively milder form of that disease than a natural infection or an inoculation with material directly from the body of a diseased hog. This, however, does not prove that every inoculation with cultivated material necessarily produces a milder form of swine plague than any natural infection or direct inoculation, for such is not the case. The difference may be stated thus: A natural infection, or an inoculation with material directly from a diseased animal, as a rule, produces a malignant attack, and as an exception a mild case of swine-plague, the frequency of the exceptions, it seems, depending to a great extent upon the prevailing character of the disease, while an inoculation with cultivated schizophytæ, as a rule, is followed by a mild attack, and as an exception, or in rare cases only, by swine plague in a malignant form.

External influences proceeding from the weather, temperature, and condition of the atmosphere, seem to further, or as the case may be, to retard the development and propagation of the swine-plague schizophytae, and may thus contribute in causing one epizooty to be more malignant than another, and thereby somewhat retard or accelerate its spreading. At any rate the malignancy of the morbid process and the rapidity with which swine plague is spread is by no means the same in different seasons and at different localities. As has already been mentioned, swine-plague was very malignant in Champaign County in 1878, while in 1880 the deaths have been comparatively few, and the spreading has been very slow. Still, the disease has not died out; isolated cases of infected herds can always be found, especially at the borders of the timber; but in many of those herds the disease exists in such a mild form and causes so few deaths that in some cases even the owner, unless he is attentive and looks after his pigs, remains sometimes ignorant of its existence till the death-rate increases. This difference in the malignancy, however, seems to be due to a small extent only to the weather and the condition of the atmosphere, &c., because other influences, proceeding from the peculiarities of the locality, and especially the degree of predisposition possessed by the individual animals contribute considerably. As has been observed before, the offspring or immediate descendants of swine previously affected with the plague and which had recovered before the offspring was born, seem to possess less predisposition than the parent.

Still, the following facts which can be observed everywhere have probably more influence upon the malignancy of the morbid process, and upon the rapidity with which swine plague is spreading, than all other causes and influences combined.

It is always found that the more general the prevalence of swine plague the more violent the individual attacks, and the more malignant the latter the more rapid is the spreading of the disease. If the plague is compelled to subside for want of material, because nearly every pig has died, it will lack a good start when, after some time, the number of swine has increased. Its prevalence must first become extensive before it can regain its old malignancy, and as long as the latter has not been obtained the spreading will be comparatively slow. Cases with intestinal lesions (ulcerous tumors in the cæcum and colon) must become numerous before the epizooty will get a good start. The severe winter of 1878-'79, the continued snow, and the scarcity of swine toward spring—nearly all the swine had died or been butchered—came near stamping out swine plague in all those parts of this State in which it was extensively prevailing in the fall of 1878, and till now it has not been able to get its old foothold, but is making very good progress in some parts of the State, and unless we get a hard winter it may be as bad in 1881 as it was in 1878.

8. The morbid process.

The morbid process, as stated in my former reports, seems to be brought about by the schizophytæ clusters (zoögloea-masses or coccoglia) obstructing the finest capillaries in the affected tissues, and thus interrupting in a large number of the smallest vessels the circulation of the blood. As a necessary consequence, the fluid parts of the blood (serum and fluid fibrin) transude through the walls of the blood-vessels into the tissues, and if those walls are not able to withstand the pressure, and rupture, numerous but small extravasations of blood will take place. That such is the case is very plain in the affected parts of the lungs before perfect hepatization—an organization of the, at first, fluid exudation—has been effected (*cf.* photograph, Plate III, lower part), and also in the skin. Afterwards the exudation becomes organized, that is, a cell-formation takes place, but the newly-formed cells are morbid—different from the cells of which the normal tissue is composed—and show a great tendency to decay or to collapse into detritus; they lack vitality. This process is especially very plain in the ulcerous tumors in the cæcum and colon, and in the sloughs in the skin, but can be observed also in the lungs. The ulcerous tumors, superficially examined, appear to be an excrescence of the mucous membrane of the intestine, but the microscope shows that such is not the case, for not only the mucous, but also the muscular and the serous coats of the intestine, and particularly the connective tissue between them show considerable thickening, and an abundance of neoplastic productions. On the whole, however, the structural arrangement of those membranes is not essentially changed, as long as a decay or collapse of the newly-formed cells into detritus has not taken place, because the morbid process, it seems, consists principally in a deposit of exudation which becomes organized or changed into new but morbid tissue. As soon as the process of decay sets in, and that, it seems, is very soon, at least in the intestines and in the skin, and also at all other places where the morbid surface is exposed, loss of substance can be observed, because the process of decay does not remain limited to the morbid products, but attacks also the original or normal tissue. Whether in the intestines, in the skin, or in a mucous membrane (conjunctiva, and mucous membrane of mouth and nose, &c.), the process is essentially the same (*cf.* microphotographs of sloughs in skin and of ulcerous tumors in cæcum and colon). If an animal recovers, a retrogressive process takes place; the morbid cells melt, and the material is gradually absorbed, provided the original tissue (lung-tissue, for instance), has not undergone essential changes. If it has, the changed or degenerated parts will also be affected by the retrogressive process, melting and absorption. If the structure of the original or normal tissue is not changed, and if no loss of substance is occurring, the affected part or organ may be restored nearly or fully to its normal condition, but where loss of substance occurs, or where the neoplastic process has been extensive, permanent changes remain. In the latter case parts or portions of the original tissue, especially if changed in structure, will melt and be absorbed the same as the morbid products and so more or less loss of substance will take place. Where substance of tissue is lost, three different processes, it seems, can take place. In the lungs, for instance, a partial loss of normal tissue may result in a shrinking of the affected part, or if the loss is not partial, but not very extensive, a cicatrix may be formed the same as in other tissues, in the skin and in the mucous membranes, for instance. An extensive loss of tissue in an ulcerous tumor in the intestines, in which the morbid change

extends to all three membranes, and especially if caused by decay into detritus, and not by melting and absorption, seems to be irreparable and fatal. A less extensive loss, involving only the mucous membrane, can be repaired by cicatrization. What other changes are taking place, and of what other processes nature avails herself to restore partial health after a severe attack of swine plague—a restoration to perfect health probably never occurs—I am unable to state; the number of *post-mortem* examinations of animals that recovered are yet too limited.

During my present investigation I have not been able to observe any chemical action, or any directly poisoning effect of the swine schizophytæ upon the animal organism, that can be at all compared with the virulent properties of certain schizophytæ of the genus *bacillus*, *bacillus anthracis* for instance, which effects a decomposition of the blood in the living animal. The blood of animals, affected with swine plague, of course, undergoes changes in its composition, and diminishes in quantity as soon as the morbid changes become important and extensive enough to interfere seriously with the process of respiration and nutrition, because material is constantly wasted and the supply with new material is very insufficient; but a decomposition or fermentation does not take place, at least not as long as the animal is alive, and cannot be observed in the fresh blood immediately after death. The blood corpuscles, if examined under the microscope, show very often, but not always, a crenated appearance, but healthy blood frequently does the same. The white blood corpuscles, on the whole, seem to be more numerous in swine-plague blood than in healthy blood, but are never numerous enough, unless the animal has been sick for a long time, and is very much emaciated, to justify one to consider their increase as an important and characteristic feature of the disease. The color of the blood is usually dark and appears carbonized wherever the affection of the lungs is extensive, but is of a normal red if the morbid changes in the lungs are limited, say to less than one-third of the pulmonary tissue; consequently the darker color often met with does not need any explanation, and is simply the result of the lungs being unable to effect sufficient decarbonization. The coagulation of the blood proceeds the same as in the blood of healthy animals, and neither perceptibly faster nor slower; and the quantity of serum contained in the blood is only abnormally increased, or, more correctly, the amount of solid constituents is only abnormally diminished if the morbid changes are extensive, and if the animal has been sick for some time and is considerably emaciated. In animals which die before much emaciation has taken place the blood invariably presents a normal appearance and is of a normal composition, with the exception that it contains swine-plague schizophytæ, mostly in shape of micrococci, and is of a darker color, or carbonized.

9. Stage of colonization.

In my former reports I gave the average time at about six to seven days. This year, however, I have met with more cases than formerly in which what I consider as the extremes have been reached. Pigs Nos. 4, 5, 10, 11, and 12 (in all, five in which the disease had a fatal termination) were taken sick within five days after the inoculation, while pig No. 17 had been inoculated nearly fourteen days before it showed plain symptoms of disease. I say "nearly" fourteen days, for it may have shown symptoms a day or two before my visit on November 20, which were overlooked, but when I saw it on that day it evidently had not been sick

longer than a day or two. The duration of the stage of colonization (period of incubation), it seems, does not so much depend upon the individuality of the animal—experimental pigs inoculated on the same day with the same material commenced to show symptoms of sickness never more than a day apart, and usually on the same day—as upon the intensity of the infectious principle, or, in other words, upon the number of swine-plague schizophytæ transferred, and upon the stage of development in which the same happen to be when the inoculation is made. When pig No. 17 was inoculated the second time, the weather was cold, and the material had been carried over 200 miles in a bottle sealed airtight. The material used for the inoculation of pigs Nos. 4 and 5—pig No. 5 showed the shortest stage of colonization, and showed plain symptoms after four days—was obtained in the neighborhood, and that used for pigs Nos. 10, 11, and 12 was from a malignant case and contained innumerable schizophytæ. Hence probably its more rapid action. The stage of colonization in the pigs inoculated with cultivated schizophytæ (pigs Nos. 2 A, and 2 B) was a long one, ten days in both animals. To sum up, two weeks or fifteen days seem to be the utmost limit, and six or seven days the medium time. The shortest possible time I am not prepared to state; it may be two days or even less, as has been asserted. It seems that the stage of colonization is usually shorter in the summer than in the winter. If in my experiments the stage of colonization has proved to be of longer duration than in those of others, the difference is probably accounted for by the manner in which I inoculated. I inoculated invariably in the external surface of the ear, an organ that carries but little blood and is remote from the heart, and as nearly all my inoculations have been made with a very small inoculation needle, and usually without drawing any blood, only a very small quantity of the infectious principle has been transferred at each inoculation.

10. MEASURES OF PREVENTION.

To devise effective measures and means of prevention, easy and convenient of application by every one, has been the principal aim and object of my present investigation. Last year certain antiseptics, such as carbolic acid, hyposulphite of soda, and a few others, but the latter not extensively, were used in several large herds with very satisfactory results; for this year it remained to subject the same to a critical test. Last year, when whole herds were treated, it could not be ascertained with certainty whether all the animals treated with the antiseptics, and to all appearances protected and saved by their use, had really become infected or not. That they had was probable, because all had been exposed, but it was not absolutely certain. This year I determined to make the infection a certainty, and inoculated the animals (experimental pigs) to be treated in a manner which had never failed to produce the disease until it failed once in October last in pig No. 17 when inoculated the first time, as has been stated and explained in another place. In all other cases special pains were taken, and neither time nor expense spared to obtain reliable material and to keep it pure at least till the inoculations had been made. Hence, as heretofore an inoculation with swine-plague material (lung-exudation), provided the animal never had an attack before and was left to its fate by not interfering with the action of the infectious principle, has never failed to produce the disease in due time, it must be supposed that at least every *first* inoculation made this year, except that of pig No. 17, would have produced the disease if no medicines had been used. But, as the record of the experi-

mental pigs shows, none of the pigs treated with antiseptics (carbolic acid, iodine, or benzoate of soda), soon, or immediately after having been inoculated, contracted the disease, and every one of them resisted the effects of subsequent inoculations, No. 9 perhaps excepted, which never fully recovered from its first attack. Some of the pigs, it is true, exhibited symptoms of a very mild reaction, but none of them became diseased, and it is evident that the continued use of the antiseptics prevented the development of the morbid process. While all three antiseptics used (carbolic acid, iodine, and benzoate of soda) proved to be equally effective, carbolic acid, for reasons already stated, deserves preference. It is true a pound of the best crystallized carbolic acid—and I have used no other—is not very cheap, but the small doses required (about 10 drops of a 95 per cent. solution, three times a day, for every hundred pounds of live weight) do not make it an expensive medicine. Thymol, or thymic acid, is probably just as effective, and as the doses required are very small the very high price of that drug might not forbid its use, but not being able to obtain a pure article when I had use for it I did not test its efficiency this year.

According to the results of my experiments and observations, carbolic acid is the preventive which I can most recommend; it proved to be effective in every case, except where its use was not commenced before serious morbid changes had taken place. Still, in the diluted form in which I gave it to the pigs it is not a direct or killing poison to the swine-plague schizophytæ. Its effect in the animal organism seems to be an accumulating one, changing or destroying the conditions necessary to the development and propagation of the schizophytæ, and especially preventing the formation of zoöglœæ-masses or coccoglia. Its continued use, say for two or three weeks, seems to place the animal in the same or in a similar condition as that of a pig which has recovered from an attack of swine plague, that is, as far as the infectious principle of that disease is concerned. It probably destroys the conditions necessary to a glia-formation, and, maybe, nothing else. The other antiseptics used seemed to have a similar effect. If no glia (coccoglia or zoöglœæ-masses) can be formed, the swine-plague schizophytæ are probably not able to produce any morbid changes, because they are sufficiently small to pass through the whole vascular system—through the finest capillaries—till they reach a part or an organ which can eliminate them again. One thing, however, must not be lost sight of, as it may have contributed a great deal to the favorable results of the treatment with carbolic acid and the other antiseptics. In all my experiments the inoculated animals, while treated with carbolic acid, iodine, or benzoate of soda, were kept by themselves in clean pens, and separated from other diseased animals, at any rate by a board partition; their food was not contaminated with the infectious principle, except once in the case of pig No. 9, as has been stated, and their water for drinking was drawn three times a day from a good well, and therefore always fresh, especially as the troughs were always emptied before any water was poured in. I consider this as important, because if the pigs treated are confined with other diseased pigs, or have to consume food or to drink water repeatedly contaminated with swine-plague schizophytæ, which are constantly discharged with the excretions (dung, urine, &c.) of the diseased pigs, the effect of carbolic acid or of any other antiseptic may not be sufficient to overcome the continued influx, unless the doses are much increased, which probably would be otherwise injurious to the animal. A strict separation of the animals to be protected from those evidently diseased, clean water, and clean food I look upon as very

essential to an effective prevention. In making such a separation care must be observed to take the animals to be protected to a place which is, if possible, on higher ground than the lot occupied by the diseased animals, or at any rate on ground which does not receive any drainage or water coming from a place (lot, pen, or pasture) occupied or frequented by diseased swine. Neither must the same contain a straw-stack or anything of a similar character calculated to catch, to harbor, and to protect the swine-plague schizophytæ, and to constitute thus a constant source of infection.

EXPERIMENTS WITH CARBOLIC ACID IN HERDS.

A carbolic-acid treatment for the purpose of prevention has been instituted in several infected herds, and the result, as far as I have been able to learn, has been invariably the same. In no case did any deaths occur among those animals which received regular doses of carbolic acid before they exhibited plain symptoms of swine plague, or before serious morbid changes had been produced. Among the infected herds thus treated I will mention: Mr. Philippi's visited May 24; Mr. William Carson's, visited June 16; Mr. Postlewhaite's, visited June 27; Mr. Lytle's, visited August 23 and September 7, and Mr. Bailey's, visited August 24, August 25, and September 6. Still, as the treatment in those herds had to be left to the owners, and as most of them live a considerable distance from Champaign, I cannot give any detailed accounts and have to rely as to the results of the treatment, &c., on the reports received, except in regard to the two last-named herds, which I visited and examined again. In both the losses had ceased at my last visit.

Inoculations with cultivated schizophytæ as means of prevention.—Having observed in my former investigations that an animal which has once recovered from an attack of swine plague does not easily contract the disease again, and if it does only in a comparatively mild form, and having also observed that an inoculation with cultivated material (swine-plague schizophytæ cultivated in innocent fluids foreign to the organism of a hog) is usually followed by a much milder form of the disease than a natural infection, or an inoculation with material directly from the body of a diseased animal, I thought it worth while to extend my researches in regard to measures of prevention also in that direction. As before stated I inoculated pigs Nos. 2 A and 2 B with cultivated swine-plague schizophytæ, cultivated for the former in milk and for the latter in water (April 14). In about ten days (April 24) both pigs showed symptoms of having become affected, but the attack proved to be a light one (*cf.* account of experiments and their results). Pig No. 7 was fed repeatedly with cultivated material (swine-plague schizophytæ cultivated in the white of fresh eggs, first, second, third, and fourth cultivated generation) and took the disease in a rather more severe form than desirable, but recovered and appeared to be protected against subsequent inoculations, which, at any rate, remained without effect. The animal (*cf.* its record) died afterward from other causes. An inoculation of pig No. 1 A with schizophytæ cultivated in albumen (May 3) remained without effect, probably because the animal had a very slight attack before.

I might have made more experiments in the same direction, but do not consider an inoculation with cultivated, and thereby mitigated, material (swine plague schizophytæ) as easy and practical a means of prevention against losses by swine plague as the carbolic-acid treatment. The latter, at any rate in the hands of the farmer, has several

advantages, and can be applied by every one without any difficulty whatever. On the other hand, a cultivation of swine-plague schizophytæ cannot be controlled without the aid of a microscope and the very best objectives, which are expensive and cannot be handled by everybody. Secondly, by adopting inoculations with cultivated material and by using the same extensively as means of prevention, the disease, most assuredly, will be perpetuated the same as pleuro-pneumonia in those countries in which inoculations are resorted to as a measure of protection against that disease, and we never shall get rid of it, although the losses by death may possibly be reduced to very few. Thirdly, an animal that has had an attack of swine plague, no matter how mild, is never again what it was before, because its growth, thrift, and development are more or less impaired by such morbid changes as are left behind.

With the carbolic-acid treatment it is different. In some of the animals that showed a slight reaction a few days after inoculation slight morbid changes may have been produced, but others did not show any visible reaction whatever, and their growth and development did not seem to be injured. Still, the same animals seem to have acquired immunity from the effect of subsequent inoculations or infections. This latter fact has led me to think that it may be possible to produce future immunity, that is, to destroy the conditions necessary to the formation of glia and the development of swine-plague schizophytæ, by treating an animal not inoculated or otherwise infected, for some time, say about three weeks, with regular doses of carbolic acid. At any rate, I intend to experiment in that direction. If it should prove to be the case that a continued treatment with carbolic acid without any preceding inoculation or infection is productive of immunity, even if lasting only a few months and not for life, swine plague may be considered conquered.

As to sweeping and general measures of prevention, I have nothing to add to what has been said in my former reports.

11. Treatment.

As to a treatment of swine diseased with swine plague I have but very little to say, except that my observations related in my former reports have found ample confirmation. The morbid process is such that medicines, at least, can have but little effect. They cannot remove the obstructions in the capillaries, and cannot repair the morbid changes. Three diseased pigs, Nos. 11, 12, and 13, were treated with carbolic acid, while No. 10, their mate, received no medicine whatever. Nos. 11 and 12 both died in about the same time as No. 10, and only No. 13 recovered, but was never of any account and succumbed to the first cold spell for lack of vitality or inability to produce in its body sufficient animal heat. Even if a treatment could be devised that would save the life of a diseased hog not much benefit would be derived therefrom, because a pig affected with swine plague is very seldom of any account after it has recovered unless the attack is an exceptionally mild one. Such an animal, as a rule, does not pay for its food and is a source of loss to its owner.

Respectfully submitted.

H. J. DETMERS.

CHICAGO, ILL., *December* 4, 1889.

CONTAGIOUS PLEURO-PNEUMONIA.

THIRD REPORT OF CHARLES P. LYMAN, F. R. C. V. S.

Hon. WILLIAM G. LE DUC,
Commissioner of Agriculture:

SIR: Although my recent examination of American cattle, as landed and slaughtered in England, had for its chief object the detection of the contagious pleuro-pneumonia so frequently reported by the English governmental authorities as existing among them, and the subsequent location, as nearly as possible, in the United States, of the herds from which these animals had been taken, I made my last report to you upon this subject before having had sufficient opportunity to examine as thoroughly as seemed to me desirable the details connected with this direct investigation, because I considered that, incidentally, matters of the greatest importance connected with our cattle export trade had come to my knowledge, and that under the circumstances it was very important that these facts should come to the knowledge of Congress early in the session, so that, if they deemed them of as much importance as they seemed to me, they might have time to take such action as they deemed necessary.

Therefore the second report was made, and I was obliged to content myself, at that time, with the statement that if pleuro-pneumonia existed in the West, or if there were diseased cattle in or about the points through which the animals passed on their journey eastward, the information already possessed would, after a little further time, insure its location. That time I have now had, and in this report I intend to discuss simply the facts bearing upon these two points of the inquiry. First, by tracing back the condemned animals, so far as I have been able, from England to the States wherein they were raised, and to show what likelihood there is that contagious pleuro-pneumonia exists in any of these States. Second, by submitting to you the report of Dr. W. F. Whitney, the microscopist, whose services were engaged for the special purpose of examining the diseased portions of lung brought home by me from Liverpool; and, third, by discussing, in addition to this, which may be called the direct testimony in the case, the circumstances connected with the marketing, transporting by rail, and shipping of cattle through our uninfected districts and ports to England; *i. e.*, that part of the matter which may be called the indirect testimony, or in reality a putting together of *facts* connected with this shipping business, and drawing from them what seems to me to be reasonable deductions.

The lungs condemned in my presence were six in number, and were from animals coming from Boston to Liverpool in the following named steamers, and in the numbers given: Iberian, one; Victoria, two; Brazilian, two; and from New York to Liverpool in the steamer Aleppo, one.

The history of these animals, as I have been able to learn, is as follows: Mr. Smith, butcher, bought of Mr. George Roddick, cattle salesman at Liverpool, 194 bullocks from the cargo of the steamer Brazilian, landed at Birkenhead, July 7, 1880. These animals were consigned to the salesman by Messrs. J. & C. Coughlin, of London, Ontario, Canada, who bought them in Boston, to which place they had been shipped direct from the Chicago market, via the Grand Trunk Railway of Canada, to Buffalo; thence, via the New York Central, to Albany; thence, via the Boston and Albany, to Boston. The lot consisted of steers from the States of Missouri, Iowa, and Illinois.

Mr. Alfred Dawson, butcher, bought of Mr. George Roddick, cattle salesman at Liverpool, several bullocks from the cargo of the steamer Victoria, landed at Birkenhead, July 15. These animals were consigned to the salesman by Mr. Timothy Coughlin, London, Canada, who bought them in Boston, to which place they had been shipped direct from the Chicago market, via the Grand Trunk Railway of Canada, to Buffalo; thence, via the New York Central, to Albany; thence, via the Boston and Albany, to Boston. This lot, as in the last case, consisted of steers from Missouri, Iowa, and Illinois.

Since leaving Liverpool I am advised that up to the 21st of November seven more animals were condemned, as follows: On September 5, from the cargo of the steamer Palestine, three animals. These were from a lot consigned to Messrs. Utley and Sons, of Liverpool, by Messrs. T. & F. Utley, of Boston; 44 of them were Missouri and 100 Iowa animals. They were bought in the Chicago market and came to Boston, via Buffalo and Albany, over the Grand Trunk, New York Central, and Fitchburg Railroads.

On November 9, from the cargo of the steamer Victoria, one animal. This was from a lot consigned to Mr. Ramsden, cattle salesman, Liverpool, by Messrs. Wales & McLeavitt, of Boston, all of them being Illinois steers, bought in Chicago market and shipped to Boston over the Michigan Central, Grand Trunk, Vermont Central, and Fitchburg Railroads.

On November 18, from the cargo of the steamer Bohemian, one animal. This was from a lot consigned to Mr. Hewlett, cattle salesman, Liverpool, by Mr. William Hawksworth, Brighton, Mass. They were Illinois steers, one-half purchased in Albany, coming to Boston via Boston and Albany Railroad. They had been brought to Albany from Chicago over the Lake Shore and Michigan Southern route. The other half were bought in Brighton market, Boston, and had been brought from Chicago via Grand Trunk, New York Central, and Fitchburg Railroads.

On November 18, from the cargo of the steamer Brazilian, one animal. This was from a lot consigned to Mr. William Carroll, Liverpool, by Messrs. Hathaway & Jackson, of Boston, and were all Ohio cattle, bought especially for this shipment in that State, and were shipped via Buffalo, and from there over the New York Central to Albany, thence over the Fitchburgh Railroad to Boston.

On November 21, from the cargo of the steamer Iowa, one animal. This was from a lot consigned to Messrs. Utley & Sons, Liverpool, by Messrs. T. & F. Utley, of Boston. Fifteen or twenty of them were Ohio cattle, and came direct from London, Ohio, by way of Buffalo, Albany, and Fitchburg, to Boston. The remainder were Missouri and Illinois steers, and came from Chicago by Grand Trunk Road.

With one exception this traces, I believe, all the condemned animals that have arrived at Liverpool from Boston from July 7 to November 21, 1880. (The one not traced was from the cargo of the steamer Iberian,

landed July 14; the reason for this will be described further on in this report.) From it will be seen that the native States of the condemned animals are Missouri, Iowa, Illinois, and Ohio; that the only markets through which they have passed are Chicago, Buffalo, Albany, and Boston; that the lines of rail that have been used are the Lake Shore and Michigan Southern, Michigan Central, Grand Trunk line of Canada, New York Central, Vermont Central, Boston and Albany, and the Fitchburg, or, as it is sometimes called, the Hoosac Tunnel route.

Cattle from the United States, upon being landed in Liverpool or at Birkenhead, are driven into stables erected for the purpose upon the wharves upon which they are landed, and are tied up in rows facing each other between which there is a passage way. After they have remained here, resting and feeding for at least twelve hours, they are examined by the veterinary inspector of the port, and, after they have passed this examination the salesman to whom they are consigned is at liberty to sell them, and the butcher who buys them, to drive them into the shambles, also situated upon the same wharf, where they are killed under the restriction that all *lungs* must be laid aside until they have been examined by the inspector, when those not condemned may be disposed of in any way that the owner sees fit. This examination is made by clasping, one at a time, the lungs between both hands, and in this position passing them over their entire surface, when, if anything peculiar is *felt*, it is cut down upon and examined. In this way the slightest variation from the normal becomes at once apparent; in fact, it is surprising how quickly the smallest change in them may be located. In this connection I also wish to have the fact borne in mind that in no one of these cases condemned in my presence did the inspector discover the disease before the animal was killed, although every animal was closely inspected in the way described, and in no one case was there any appearance about any one of these condemned animals that caused the slightest question to be raised as to its healthfulness, notwithstanding he had but very recently passed the scrutiny both of the port inspector and the butcher who had bought him; nor was there one of them that was not fully up to the average of his fellows in flesh.

The microscopic appearances of these six lungs in their fresh state were as follows:

Brazilian No. 1.—This lung contained, in about its center, a large, hardened object that could be both seen and felt, and would measure, perhaps, about six inches through its largest diameter. This, upon being cut into, appeared to be an abscess containing nothing put a pure, rather thick, creamy pus, and, although any portion of dead tissue that might be contained within this cavity was thoroughly searched for, nothing of the sort could be found. The cavity was surrounded by what seemed to be a rather thick cartilaginous wall, this again by a considerable amount of "marbled" tissue in which the parenchymæ was of an even pinkish color, with the interlobular thickening well marked, white, hard, and firm. This, in its turn, passed almost imperceptibly, the parenchymæ becoming gradually more and more areable, and the interlobular thickening growing narrower and narrower into the healthy lung tissue surrounding the whole.

Brazilian No. 2.—This lung, with its fellow, upon its surface, presented to the eye no indication of disease, but upon being handled in the way described above, several small nodules within its substance at once became apparent; these, upon being cut down upon, in the one lung disclosed the unmistakable lesions of tuberculosis, and in the other, where these indurations felt were much fewer and smaller, the

nodules showed the peculiar lesions upon which it was condemned. There were several small nodules situated in the periphery of the extreme posterior portion of the large lobe of the right lung, the larger of which was about one-half inch in diameter; in its center there appeared to be a cheesy deposit; this was surrounded by a very thin layer of a thin grayish-colored pus; outside this a very thin membrane; outside this again, a very limited amount of marbled tissue, which, near the center, was well marked, but more indistinct toward its outer margin. Of these nodules there were some four or five perfectly isolated from one another, but all being, to the unaided eye, of the same description.

Victoria lungs.—There were two pairs of these, condemned from the same lot at the same examination. One lung showed one and the other three indurated spots upon which the lungs were condemned. The largest of these "spots" was about the size of an English walnut, and was situated exactly at the root of the lung; the remaining three were situated in various isolated positions in the substance of the lung. Upon being cut down upon they all exhibited the same general appearance as those of the Brazilian No. 2 lung already described, except that in the case of the largest specimen there was a fair amount of sub-pleural thickening, although there had been no adhesion between these surfaces. Of this portion of lung Dr. Whitney says: "The size and appearance of the diseased portion after a clean cut had been made through it is represented on Plate IV. The disease involves about one-half dozen lobules, representing about 50 to 75 cubic centimeters in bulk (Plate IV *a.*) These are quite homogeneous in appearance, and within them are seen one or two small irregularly rounded cavities containing a cheesy material. The interlobular tissue between them and the more healthy portion of the lung (Plate IV int. tis.) is very thick and dense." In its fresh state this cheesy deposit was surrounded by a thin layer of what appeared to be a thin, grayish pus; this again by a thin membranous wall, this by the "marbled" tissue, limited in extent, and surrounded on three sides by healthy tissue.

Aleppo lung.—The lung from which this specimen was taken was from a bullock killed in Liverpool July 23, and which the inspector said he considered a fine specimen of contagious pleuro-pneumonia, and, as will be seen by reference to Plate VII, which is copied from a painting made by a leading firm of photographers in Liverpool from the lung itself, on the same day upon which it was taken from the animal, and is a most perfect representation of its appearance, has very much the look of that disease; indeed so close is its resemblance that no one would be warranted in saying that it was not it until a most thorough examination had been made of the specimen.

Plate VII*a* represents the point at which adhesion had taken place between the two pleural surfaces, and at which, upon being broken down by the fingers, there was left a small rounded eminence of loosely formed connected tissue, *b*, the diseased nodule showing the discolored lobules and the greatly thickened interlobular tissue; *c c*, healthy lung tissue.

After getting this portion of lung to Boston, another cut was made into the nodule parallel to the first, and at a point directly through the center at *a*. The surface thus exposed had a very different appearance. At about the center of the nodule was a small, irregularly shaped cavity surrounded by a mass of material having a grayish cheesy look; in fact giving precisely the appearance noticed in all of the specimens except the Brazilian No. 1.

Iberian.—This specimen was not retained by me, nor were any inqui-

ries made about it that would enable me afterwards to trace the animal in the United States, because at the time it was discovered by Mr. Moore, the inspector, and shown to me, I did not think that there was the slightest indication of pleuro-pneumonia about it, and so told Mr. Moore, who, I thought, agreed with me at the time, and so the lung was not retained. Two days afterwards, however, I found, much to my surprise, that it had been condemned and reported to the London authorities as having been a case of pleuro-pneumonia. My recollection of its appearance is that it contained seven or eight nodules isolated from one another, consisting of a small cheesy deposit no larger than a pea, surrounded by a thin membrane, and showed *no* marbled tissue whatever.

In addition to this description I may say that every specimen described in this report was seen and examined by Inspector Professor Duguid, of the London office, and pronounced by him to be undoubtedly pleuro-pneumonia. Also that each and every one of them were shown in August last to Professor Williams, who declared that, in his opinion, none of them were pleuro-pneumonia unless it was the Aleppo specimen, upon which he would give no opinion without a chance for a more minute examination of it.

MICROSCOPIC EXAMINATION.

All of the specimens of lungs which I have endeavored to describe were given by me to Dr. W. F. Whitney, of Boston, Mass., curator of the Warren Anatomical Museum, and assistant in pathological anatomy in the medical department of Harvard University, who made a most thorough microscopical examination of them, and whose report upon the subject I have the honor to herewith submit:

BOSTON, MASS., *December* 30, 1880.

CHAS. P. LYMAN, F. R. C. V. S.,
Veterinary Surgeon, Department of Agriculture:

DEAR SIR: At your request I have examined the portions of lungs coming from American cattle killed in Liverpool, said to be affected with contagious pleuro-pneumonia.

From a careful study of those specimens in comparison with others obtained from an unquestionable case of that disease, from the description of its characteristics as given by Williams, Yeo, Roy, and others, it appears that the changes seen in those specimens are caused by *chronic inflammatory processes, especially of the interstitial tissue, in some cases combined with miliary tuberculosis, which, reasoning from analogous processes found in the human lung, are not contagious.*

In proof of the above statement I send you herewith the preparations upon which it is based, with drawings, and in explanation of them will call your attention, first, to the relations of the healthy lung, then to the changes seen in a lung affected with contagious pleuro-pneumonia, and, finally, to the manner in which the changes seen in the specimens sent for examination differ from those of that disease.

The lungs of cattle differ from those of man, in that each lobe is distinctly subdivided into numerous lobules (each occupying the space of from 10 to 30 cubic centimeters) joined to each other by fine bands of connective tissue, which also forms the walls of extensive lymph spaces, connecting on the one hand with those lying in the pleura, and on the other with the lymph canals, which nearly surround the blood-vessels accompanying the bronchus into the lung tissue. These relations are shown in the preparation marked "normal lung of bullock, lymph spaces injected with blue," and from which Plate I has been drawn. Fig. 1 represents a section through the whole of one and part of an adjoining lobule with the uniting bands of connective tissue inclosing lymph spaces. The extreme thinness of this band is especially to be noticed. The walls of the alveoli, which form the tissue proper (Fig. 1, lung tis.) are fine, and have a slightly wavy crinkled outline, and in them are a few scattered lymph and epithelioid cells. One or more small bronchi are usually to be found in each lobule. A more highly magnified view of one of these is represented in Fig. 2. In this can be distinguished three coats, a mucous or inner coat, a muscular or middle coat, and an external coat. The mucous coat (Fig. 2, muc. ct.) is formed by a layer of columnar epithelium, its inner surface resting upon a narrow zone of connective tissue (submucous coat) which is

thrown into folds when the bronchus is contracted. The muscular coat (Fig. 2, mus. ct.) is composed of unstripped fibers arranged concentrically. Outside of this is the external coat, composed for the greater part of a collection of round cells, probably of a lymphoid character, separating it from the accompanying artery and vein (Fig. 2, art. and v.), which are almost surrounded (in some places entirely so) by the lymph canals (Fig. 2, lym. sp. c.).

In the diseased lungs the changes occurring in the connective tissue, including the lymph spaces, in the alveoli with their walls, and in the bronchi, will be considered and compared with each other.

CONTAGIOUS PLEURO-PNEUMONIA.

Contagious pleuro-pneumonia presents three stages (designated as A, B, and C), dependent upon the degree to which these tissues are affected.

In the earliest or stage A (see preparation marked contagious pleuro-pneumonia, stage A, from which Plate II has been drawn) the most marked changes are in the lymph spaces. Those in the pleura are in a great measure obliterated by the growing together of its two layers, and such as remain (Plate II, lym. sp. A) are filled with young round cells, leaving only a narrow passage close to the wall. The interlobular spaces (Plate II, lym. sp. B) are filled with a semi-gelatinous fluid, which in hardened specimens becomes coarsely fibrillated and in which are a few scattered round (lymphoid) cells. The bands of connective tissue forming the walls of the lymph spaces are but slightly thickened. In the lymph canals about the vessels are a few clumps of lymph cells. The opening of the canal is in general free (Plate II, Figs. 1 and 2 lym. sp. c.).

The walls of the alveoli have no longer a crinkly outline, but a slightly stiff appearance, giving the alveoli a much rounder look. This is partly due to an engorgement of the vessels and partly to an increase of lymph and epithelioid cells in and upon the walls (Plate II, Fig. 1, lung. tis.).

In the small bronchi the changes are confined to the mucous coat (Plate II, muc. ct.), which is thickened from a proliferation of the epithelium, the cells next the free surface having a tendency to degeneration as shown by a slight detritus.

In the second stage (see preparation contagious pleuro-pneumonia, stage B) the exudation in the interlobular lymph spaces is firmer and there are a greater number of cells. The walls of the spaces are but little changed from the preceding stage. The canals about the vessels are more extensively filled with cells, and here and there a vessel is plugged.

Most of the alveoli are filled with an exudation, in places resembling that in the interlobular lymph spaces in stage A, and similar to that found in croupous pneumonia of the human lung, in places consisting entirely of lymph and epithelioid cells. The contents of certain of the alveoli take coloring matter badly, showing that a degeneration has taken place in the cells.

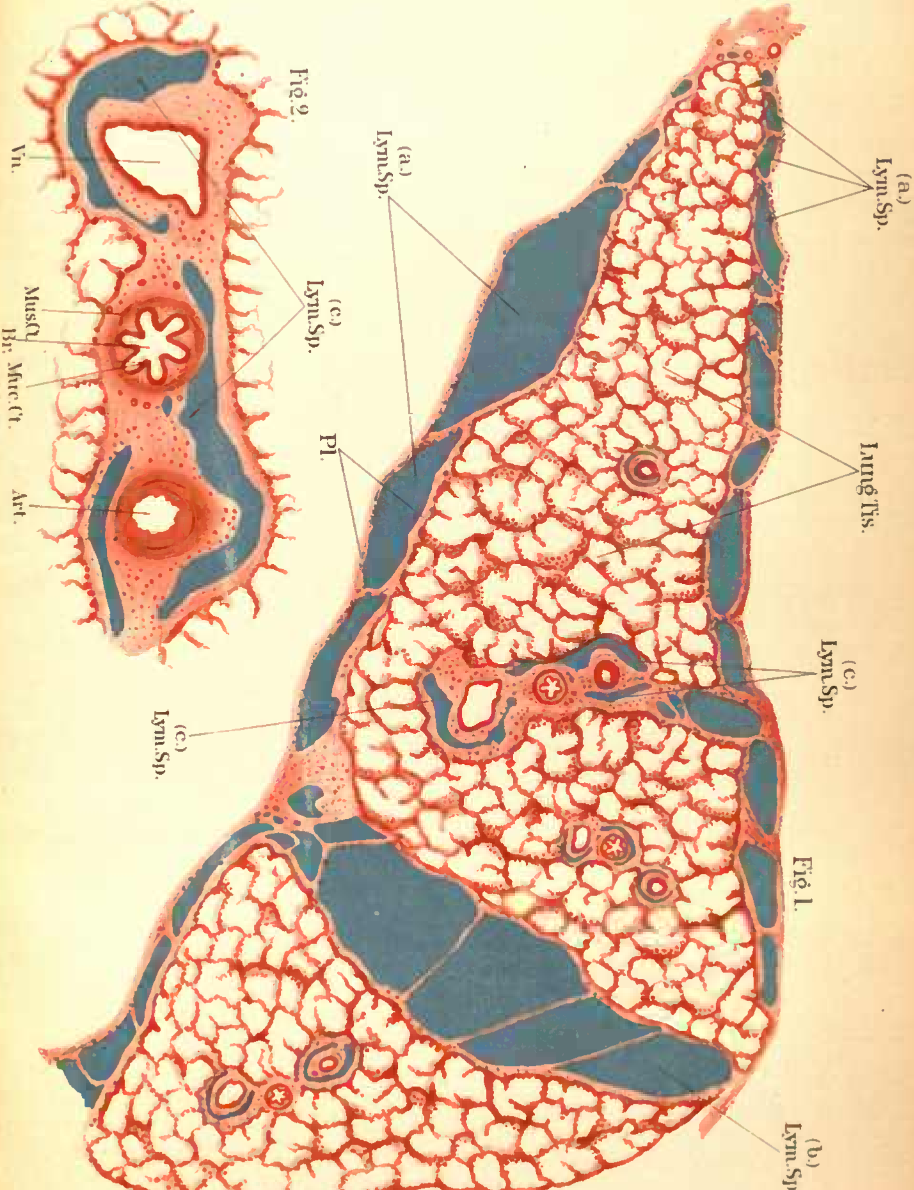
The mucous membrane of the bronchus is much thickened, and in the opening of the tube is to be seen detritus of exfoliated and degenerated epithelium.

In the third stage (see preparation marked contagious pleuro-pneumonia, stage C, and from which Plate II has been drawn) the interlobular exudation is a little firmer and more fibrillated, the original walls of the lymph spaces are still to be distinguished as moderately thickened bands (see Plate III, Fig. 1 lym. sp. B). The canals about the vessels (Fig. 1, lym. sp. C) are completely filled with lymphoid cell, the vessels are usually plugged, and a more or less extensive hemorrhage may take place into the surrounding tissue (see Fig. 1, art).

The alveoli are filled with lymph and epithelioid cells, in many cases degenerated and retracted from the walls into little granular clumps. The walls themselves are much thickened in some places from a hypertrophy of the fibers of unstripped muscular tissue, which is normally present in small amount, especially at the place where the bronchus passes into the alveoli (see Fig. 2, mus. hyp.).

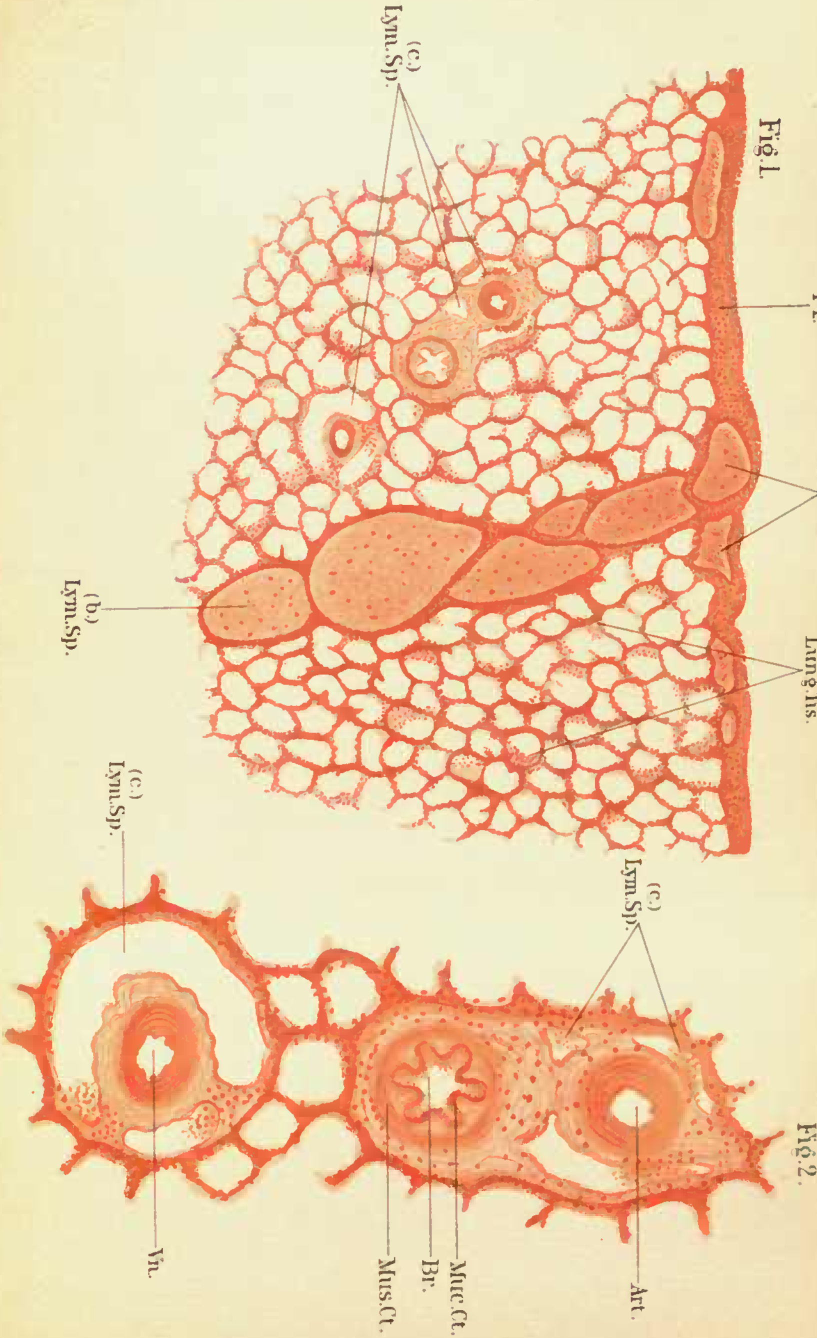
The bronchi in this stage are only distinguished with difficulty, and the explanation lies in the fact that the mucous membrane has become entirely degenerated and cast off from the walls (see Fig. 1, br. muc. ct.), the cells reduced to a detritus, which, together with lymph and blood cells, completely occlude the opening, leaving no characteristics by which to distinguish it from any other plugged vessel.

Upon grouping together the appearances as presented in the different stages, it is manifest that the lymph spaces are at first filled with a coagulable material, and the increased density of this in the later stages of the disease is due to an increase in the number of cell elements and not to a material increase in the thickness of the walls of the spaces. With the increasing firmness of this exudation the alveoli are filled with cells and exuded material, as are also the lymph canals about the vessels; and when this has reached a marked degree, the mucous coat of the bronchus, which in the earlier stages of the disease has taken part by a proliferation of its epithelium, is cast off and the tube is filled with its detritus and an exudation similar to that in



CONTAGIOUS PLEURO-PNEUMONIA

A. Hoen & Co. Lithocaustic, Baltimore



CONTAGIOUS PLEURO-PNEUMONIA

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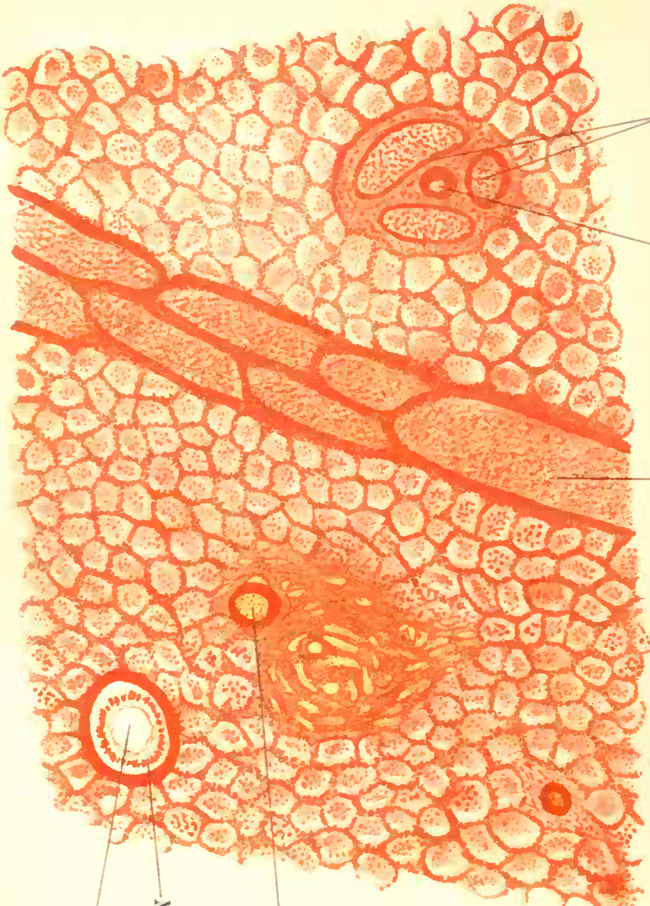


Fig. 1.

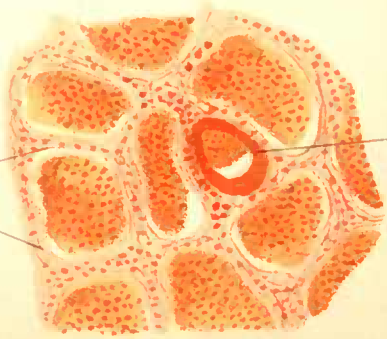
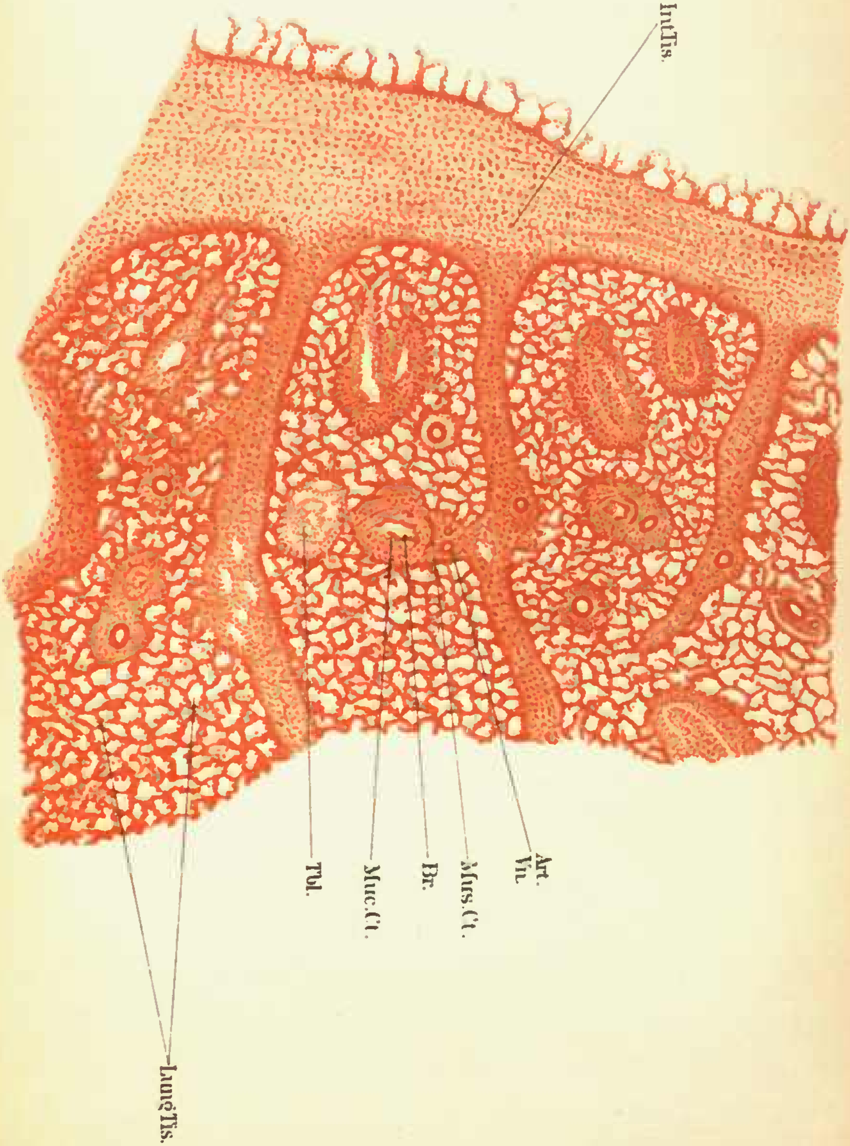


Fig. 2.

CONTAGIOUS PLEURO-PNEUMONIA

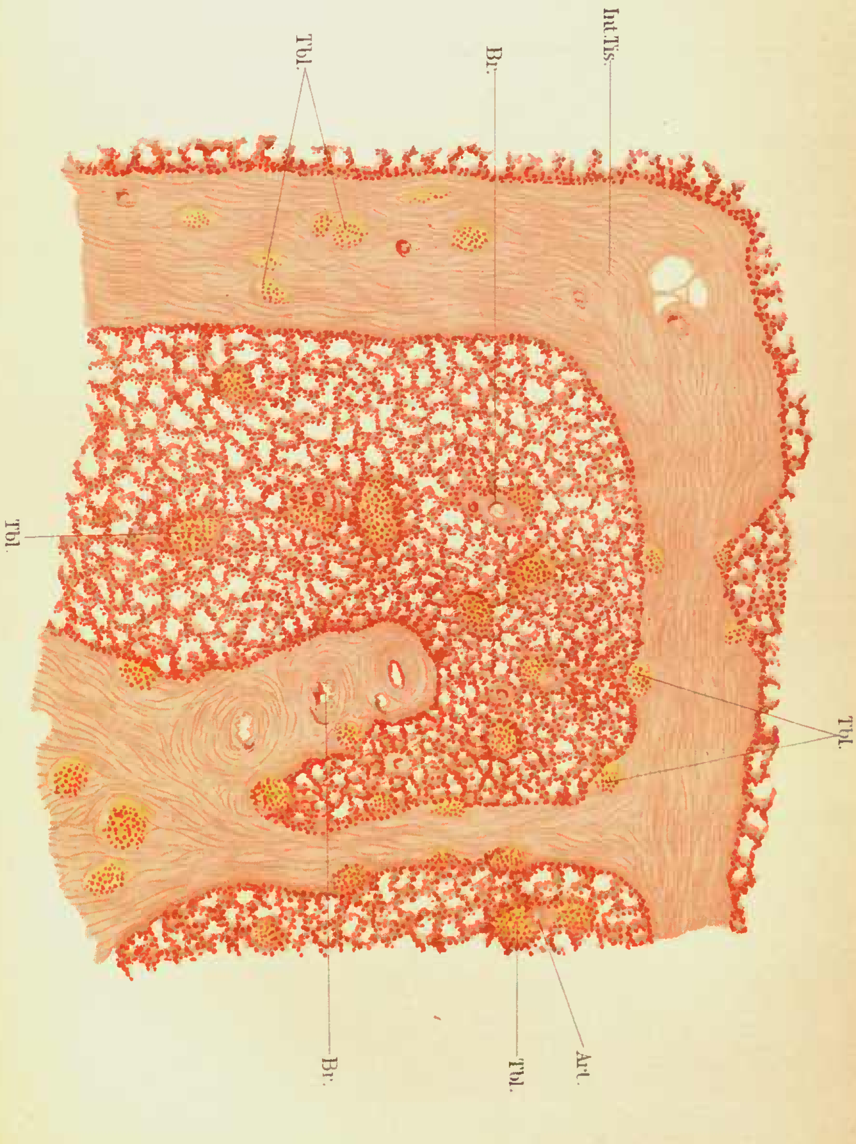
CONTAGIOUS PLEURO-PNEUMONIA

A Hoen & Co. Lithocaustic Baltimore



CONTAGIOUS PLEURO-PNEUMONIA

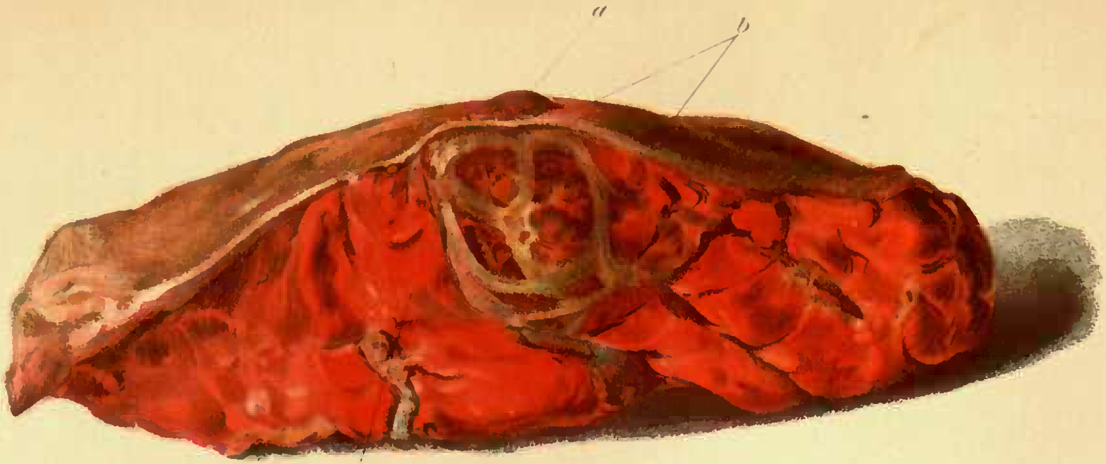
A. Hoen & Co. Lithocaustic. Baltimore.



CONTAGIOUS PLEURO-PNEUMONIA

A. Hoen & Co. Lithocaustic. Baltimore.

Contagious Pleuro-Pneumonia of Cattle.



Portion (natural size) of condemned lung from American Bullock, slaughtered in Liverpool, England.

A. Hoen & Co. Lithocaustic Baltimore

the neighboring lymph canals. The muscular coat of the bronchus resists longer and can be clearly distinguished after the mucous coat is destroyed. With this filling of the lymph canals the vessels are occluded and hemorrhage may take place into the surrounding tissue.

DISEASED LUNGS FROM LIVERPOOL.

The one first examined was marked "Steamer Victoria, from Boston, July 19, 1880, Liverpool," and will be referred to as the Victoria lung.

The size and appearance of the diseased portion after a clean cut had been made through it, is represented in Plate IV. The disease involves about one-half a dozen lobules, representing about 50-75 C. C. in bulk (Plate IV, A). These are quite homogeneous in appearance, and within them are seen one or two small, irregularly rounded cavities, containing a cheesy material. The interlobular tissue between them and the more healthy portion of the lung (Plate IV, B) is very thick and dense (Plate IV, int. tis.).

The whole has a resemblance to contagious pleuro-pneumonia in that the lobules and interlobular tissue are involved, but differs in the small amount of tissue implicated when considered in relation to the *degree to which* the interlobular tissue is affected. What the cause of these changes is will be understood from the preparation marked S. S. Victoria, &c., and from which Plate V has been made.

Looking first at the interlobular spaces it will be seen that there is no longer any trace of the lymph spaces, but that the lobes are joined by a firm band of connective tissue, rich in young cells (Plate V int. tis.). The earlier stages of this are seen in that part of the preparation which shows no changes to the unaided eye (this is not shown in the drawing), and there it appears that this tissue results from a thickening of the walls of the lymph spaces. Later, when this has become dense, an accumulation of cells takes place in the contracted spaces and the whole becomes fused into the firm mass shown in the drawing.

From the action of this connective tissue the alveoli are compressed and the walls are slightly thickened from the presence in them of large numbers of young cells. There is but little tendency, however, to exudation or accumulation of cells within the alveoli.

The greatest changes within the lobules are seen about the bronchi and their accompanying vessels. It will be remembered that there is normally a narrow zone of connective tissue, rich in cells, surrounding the bronchus and separating it from the adjacent vessels. These cells have proliferated to such an extent as to form a wide band about the bronchus, involving the blood vessels, which are, however, still pervious, but compressing the lymph canals to such an extent that their presence is with difficulty made out. The coats of the bronchi are also affected, but in the reverse order from what they are in contagious pleuro-pneumonia, viz: The muscular coat has almost disappeared (see Plate V, mus. ct.), while the mucous coat (see Plate V, muc. ct.) remains quite distinct, and the opening of the bronchus (contrary to the case in pleuro-pneumonia, when the cellular exudation is as extensive as here) is patent and even slightly dilated (condition known as bronchiectasis). This proliferation about the bronchi (known under the name of peribronchitis) may become degenerated finally and thus give rise to the small cavities filled with cheesy detritus noted in the description of the specimen (Plate IV, A).

The commencement of such a degeneration may account for the appearance seen in the middle lobule of the preparation (see also Plate V, tbl.), or it may be due to a secondary tuberculosis.

The whole process can be classified as one of chronic interstitial pneumonia, with peribronchitis and bronchiectasis with the formation of cavities.

STEAMSHIP BRAZILIAN, FROM BOSTON.

The next two specimens examined were both marked S. S. Brazilian, from Boston, and will be described as Brazilian lung No. 1 and No. 2.

Brazilian lung No. 1 consisted of several pieces forming part of the wall of a large abscess. The side of the specimen which lay next to the cavity of the abscess was quite smooth, and the tissue immediately adjoining was firm, dense, and quite homogeneous, so that the outline of the lobules could only be made out with difficulty. This very dense portion extended for about 1–2^{cm}, when the tissue began to assume more the appearance of normal lung; only that between the lobules were firm bands connecting directly with the dense tissue near the edge.

Two preparations were made from this, one from the dense portion and the other from the more healthy looking part.

Upon examining the former (see preparation marked S. S. Brazilian No. 1, near abscess wall, and from which Plate VI has been drawn) it will be seen that the great

increase in density is principally due to an increased thickening of the interlobular tissue (see Plate VI, int. tis.), and upon comparing this with the preparation made from the more healthy portion (see preparation marked S. S. Brazilian, recent disease) it will be found that this increase is due, as in the case of the Victoria lung, to a thickening of the walls of the lymph spaces rather than to an organization of a material filling the lymph spaces.

In the thick bands of connective tissue traces of small vessels are seen, showing that the process has been of long duration. The bronchi lying in their midst are still open and to be distinguished by their epithelial lining, but their muscular coat has almost disappeared.

In the recent preparation the alveoli show simply the results of compression, with an increase of round cells in their walls. Near the abscess wall the lobule is quite solidified, but this is due not to an exudation into the alveoli, but to the effects of the compression of the connective tissue and to a thickening of the walls by a round cell infiltration. Scattered through the alveoli lobules, replacing one or two alveoli, in the walls of the smaller bronchi and in the bands of new formed connective tissue are small circular collections of round cells, having a tendency to degeneration with a sharp line between them and the surrounding tissue (see Plate VI, tbl.); these are probably minute points of chronic purulent inflammation, but may belong to the class of tubercles, although only about half the size of those bodies and lacking in giant cells and stroma.

The changes found in this lung are those of chronic induration, which are entirely explained by the proximity to the large suppurating cavity, and have nothing in them indicative of what may have been the cause of it.

Brazilian lung No. 2.—In the second specimen from the Brazilian there were two nodules from different parts of the lung, showing different stages of disease, the one more advanced than the other.

In both of these nodules there were only a few lobules which presented any changes from the normal, and in the more recent specimen it was only in a single lobule that these changes reached a marked degree.

In this the lobule, which was the center of the disease, was quite homogeneous, except in the middle, where a portion of the tissue was separated from the rest by a distinct line of irregularly indented outline. In this portion were numerous small losses of substance, giving to the whole a slightly necrosed look. This central lobule was separated from the adjoining ones by a firm, broad band of tissue, while in the more remote interlobular spaces the walls of the lymph spaces were seen to be thickened, and lying in the spaces thus reduced in diameter by this thickening of the walls, were firm, fibrous-looking masses, which were only slightly adherent to the walls, and could in consequence be withdrawn intact. In contagious pleuro-pneumonia, it will be remembered, the substance filling the interlobular spaces is perfectly continuous from side to side, and cannot thus be withdrawn.

From this specimen three preparations were made, two from the recent nodule and one from the more advanced.

The first of these (see preparation marked S. S. Brazilian No. 2 (A), recent disease) was taken from the recent nodule in the tissue from the neighborhood of the central diseased lobule, and presented to the eye only a thickening of the interlobular tissue with masses in the lymph spaces. Under the microscope it was found that the walls of the lymph spaces were thickened in the same way as in the previous cases, and that the masses lying in the spaces were composed entirely of cells, having none of that peculiar loose, meshed, fibrillated network characteristic of contagious pleuro-pneumonia. About the small bronchus, with its accompanying vessels, a dense cellular infiltration is seen. The muscular coat is quite degenerated, while in one portion of the wall of the bronchus the cells have assumed an indistinctly circular outline about a centrally degenerated point (tubercle?). The changes in the alveoli with their walls are very slight, consisting only in an increase of cells.

The second preparation was made through the central lobule, in which, as described above, was a circumscribed necrosis.

The thickening between the lobules (see preparation marked S. S. Brazilian, No. 2 (B), recent disease) is due, as in the previous cases, to a thickening of the walls of the lymph spaces, with here and there narrowed lymph spaces filled with cells more or less adherent to the walls. In the preparation colored by hæmatoxylon the necrosed portion is brought sharply out by a deep blue line, lying just within its border, and due to the presence of a large number of cells and nuclei. Within this line the alveoli are filled with yellow, finely granular detritus, in which lie scattered nuclei and cells in the process of degeneration. Very few nuclei or cells are seen in the alveolar walls, and the whole looks dead. Within the center of this necrosed portion are seen the blood vessels still pervious, surrounding which is a zone of cell infiltration as shown by the deep color. The bronchus lies between the vessels, but can only be distinguished with difficulty, since the external and middle coats are almost obliterated, the mucous coat destroyed, only one or two projections of the submucous coat

remaining to mark its character, and the opening of the tube filled with round cells and nuclei.

The walls of the alveoli of the tissue bordering this necrosed portion are very much compressed, and, together with the new cells, which have been inflated, form a sort of wall. The remaining alveoli are comparatively free, although a few are filled with the same yellow finely granular detritus as are those within the necrosed portion.

Within the nodule or more advanced disease was a cavity $\frac{1}{2}$ to 1 centimeter in diameter, surrounded by a thick wall, and the lobule containing it was separated from its neighbors by thick bands of tissue, which could be followed for some distance among the more healthy lobules.

Under the microscope (see preparation marked S. S. Brazilian, No. 2, advanced disease) it appears that the interlobular tissue is composed of the same connective tissue, only rather firmer than marks the preparations already examined, and has apparently been formed in the same way. The wall about the cavity is also composed of a similar fibrous tissue rich in cells, and passes insensibly into the walls of the alveoli which are compressed and slightly thickened, but otherwise comparatively open. Surrounding the bronchi and vessels are an accumulation of cells which have infiltrated the bronchus from without inwards, leaving still a remnant of the epitheleal lining.

The general outline of the cavity is such as to indicate that it had been formed by a necrosis of a circumscribed portion of the lung, as in the more recent specimen. This necrosed portion has been gotten rid of, and the slight wall of separation seen in the recent specimen has been thickened and condensed.

The whole process is one of chronic interstitial pneumonia with peribronchitis and necrosis of the lung tissue.

STEAMSHIP ALEPPO, FROM NEW YORK.

The specimen was a portion of lung about half the size of the palm of the hand, in which was a firm wedge-shaped nodule, the base of which measured 2^{cm} by 2.5^{cm}, and was at right angles to the pleural surface, which was slightly thickened all over the portion of lung. The nodule was quite homogeneous in appearance, with broad bands of tissue separating the lobules. In one of the lobules there were small losses of substance, giving to that part a honeycombed look, and in another lobule there was a small cavity.

The bands of interlobular tissue (see preparations marked S. S. Aleppo from New York, from diseased nodule, and S. S. Aleppo, &c., section of entire nodule) are composed, as in the previous cases, of firm connective tissue quite well vascularized, showing here and there the presence of masses of cells in the narrowed lymph spaces.

The lung tissue is compressed and the alveolar walls are thickly studded with round cells and nuclei. In the honeycombed tissue mentioned above (see preparation marked from diseased nodule) these cells are collected together in little round groups, which were often degenerated in the centers, causing the little losses of substance referred to. The alveoli themselves were filled with exuded masses, detritus, and cells.

The section through the lobule containing the cavity (see preparation marked section of entire nodule) shows that the cavity is surrounded by a thick wall having a slightly reticulated appearance and here and there giving the outline of a circular body. In the remaining parenchyma of the lung are two to three round bodies of a similar size with a rather broad meshed stroma, in which lie round cells (miliary tubercles).

The bronchi and vessels are surrounded by accumulated cells.

Many of the alveoli of the lobules bordering upon the diseased nodule are filled with blood corpuscles, which, however, lie freely within them, and have not uniformly infiltrated all the tissue as is the case in the hemorrhagic infarction of the contagious pleuro-pneumonia.

The whole process can be classified as one of chronic interstitial pneumonia, combined with tuberculosis and the formation of cavities.

CONCLUSION.

Looking at the cases as a whole, it will be seen that they are the results of inflammations of different parts of the constituents of the lungs, there also being indications in all the specimens that tuberculosis may take part in producing some of the changes.

The antecedence of one process over the other cannot be exactly determined, but judging from the thickness of the interlobular connective tissue, and the fact that it can be distinctly traced among the apparently unaffected lobules, it is probably implicated among the first, and from the fact of the thickness of this tissue as compared with the small amount of lung involved, the processes must be placed among the chronic ones, which require weeks or months rather than days for their accomplishment, and as such are probably not contagious.

Yours, truly,

W. T. WHITNEY.

Therefore, if we may place *any* value upon facts as evidenced by the microscope—and who will say that we cannot?—the absolute fact is well shown that not only were the lungs condemned in my presence as being affected with pleuro-pneumonia *contagiosa* not affected with that disease, but that the changes noticed in them, in all but one case, were due to a chronic interstitial pneumonia with peribronchitis, with necrosis and the formation of small cavities at and within the lung tissue proper; and further, there are evidences amounting to a certainty, in one case at least, that the disease known as tuberculosis, probably, plays a more or less prominent part in the etiology of these changes. The other lung (Brazilian No. 1) that cannot be included in this class of cases, was, however, very distinctive, in that the lung contained the large abscess, already described, and the microscope shows the changes in the lung tissues, upon which the condemnation was made, to have been chronic induration of these tissues, caused by the pressure upon them of the large abscess found to exist in their immediate neighborhood; in fact just the condition that under the circumstances we would expect to find. I think that, without pursuing the history of the beasts from which these lungs came, it may be safely stated that they were not affected with contagious pleuro-pneumonia. The next thing, therefore, will be to consider these cases that have been reported as being diseased with contagious pleuro-pneumonia since the time I left Liverpool, and up to the 21st of November last, of which there were seven, as has been already stated. As the lungs, or diseased portions of them, were not obtainable for examination, it will be possible only to show by negative evidence what the probabilities are respecting them. As you will remember they came to Liverpool by various steamships from Boston; to Boston they came from Missouri, Iowa, Illinois, and Ohio, and none of them were at any time in any of the cattle markets except those of Chicago, Buffalo, Albany, and Boston; and the only lines of rail over which any of these passed were the Grand Trunk of Canada, New York Central, Fitchburg, Michigan Central, Vermont Central, Boston and Albany, Lake Shore and Michigan Southern.

It will be shown further on that there cannot be any disease in Chicago or Buffalo, and the same argument will be as true regarding Albany as Buffalo. In the case of Boston I may say that ever since the "stamping out" of pleuro-pneumonia from Massachusetts in 1867 there has always existed, and does to-day, in this State a most efficient board of State cattle commissioners, composed, amongst others, of the same veterinarian (Dr. E. F. Thayer) under whose administration the disease was "stamped out," and that although this board has, during all these years, kept a most lively lookout for any cases of the disease within their State, and although thousands of animals have been examined in Brighton market, alive and dead, by Dr. Thayer, not one single case of pleuro-pneumonia has been discovered within that State within the last 14 years.

Regarding the native States of these cattle, it may be said that in Missouri this department has 104, in Iowa 84, in Illinois 86, in Ohio 83 correspondents, whose particular duty it is to inform themselves as to the nature of any disease that may at any time show itself among the animals within their district, and that these correspondents have not at any time reported the existence of any disease the symptoms of which at all similated those of contagious pleuro-pneumonia, although every special effort possible has been made to discover it should it exist there. So far as is known, and equally strenuous efforts have been made to discover the facts, pleuro-pneumonia does not exist in any region of coun-

try through which the lines of rail over which these animals have been carried passes. This, then, leaves as the only possible source of contamination the cars in which the animals have been conveyed. That the disease may have been contracted in this way is possible, but not at all probable, and as bearing upon this point it may be said that cattle going to Boston for local uses are conveyed in exactly the same way, and oftentimes in the same cars, as the animals going from thence to Great Britain; and that, although I myself have examined many hundreds of these, alive and dead, I have never yet found a single case of contagious pleuro-pneumonia; and this is the fact, as I have before stated, regarding the very extensive examinations made of these same animals by the Massachusetts State board of cattle commissioners.

In considering this question in all its phases, I am naturally led to a review of the circumstances attending the landing and examination of the cargo of animals *ex* steamship Ontario, which arrived at the port of Liverpool on the 26th of January, 1879, consisting of 195 cattle and 2 carcasses; 87 head of cattle had been thrown overboard on the voyage, thus making the original shipment 284. These animals were shipped from Portland, Me., but of their origin Mr. Welsh, Minister of the United States at London, says: "From reliable parties in Liverpool I learn that while a part of the cattle by the Ontario came from Chicago, and a part from Buffalo, at least 45 head of them came from Toronto, and were so mixed with the others that the Canadian and United States cattle could not be distinguished. It is also beyond dispute that those which came from the United States passed for several hundred miles over the Grand Trunk Road through the Dominion of Canada; that all the cattle were exposed to weather of unusual severity; that they remained for a considerable time in Portland without food or water, and that they had undergone an exceptional amount of hardship and bad usage before entering upon a voyage which was made at an inclement season and during excessively rough weather." In a memorandum on the subject, Professor Brown, of the Veterinary Department of the Privy Council, says: "On examining one of the carcasses, the inspector at Liverpool found evidence of pleuro-pneumonia, and forwarded portions of the lung to the Veterinary Department. This specimen was found to represent the characteristic indications of the contagious pleuro-pneumonia of cattle so well known in this country. By direction of the Lord President, I immediately instructed Mr. Duguid, one of the inspectors of this department, to proceed to Liverpool and report as to the condition of the animals which had been detained there. Mr. Duguid remained at Liverpool and superintended the slaughter of the cattle, and in the course of the *post-mortem* examination he detected thirteen cases of pleuro-pneumonia *in various stages*." Now take the statement of Professor Walley, made to me in Edinburgh, in July, 1880, in regard to this matter. He says:

I was called to Liverpool and there shown animals together in a building which, I was told, came per steamship Ontario from America; a few of them were coughing, I should judge giving the pathognomonic cough of contagious pleuro-pneumonia. *I examined them; they gave no elevation of temperature that amounted to anything as a sign;* they varied a little; some would be a degree higher than others, but nothing remarkable in any. While this examination was going on, *and before we had finished to my entire satisfaction*, a man came to say that we were wanted in the slaughter-house, where we went at once, and found two animals that we were told had been taken haphazard from this cargo of the Ontario, hanging partially dressed, and from these I saw lungs taken that exhibited to me, without any doubt, the well-known lesions of contagious pleuro-pneumonia. I was not at the place for more than an hour.

In answer to questions, he further said:

The animals were in as good condition as any of the others; that there were several diseased spots in their lungs; that the diseased portions were "marbled," and the pa-

renchyma varied in color from deep red to pink, but it was mostly of a pinkish shade; that there was no attempt towards the formation of a cyst-wall around any of the diseased portions, because the disease had not been of sufficient standing.

I have made these extracts because they seem to me to embrace the entire evidence tending to show that the disease on the Ontario was contagious pleuro-pneumonia; and I think it worth while to put in contrast with them here what may be called the circumstantial evidence tending to show that there may have been some mistake.

The fact seems to be beyond dispute that so far as the animals came from the United States they came from Chicago and Buffalo via. Canadian Grand Trunk Road to Portland. Since 1877 the Department of Agriculture has had, all through the West, regular correspondents, whose duty it is to collect and forward evidence relating to any disease, contagious or otherwise, that may prevail to any extent in the different localities in which they are located. In this way nearly every disease that animal flesh is heir to has received some sort of mention, but in no case has any descrpition been received that could in any way be construed into a description of contagious pleuro-pneumonia of cattle. Besides this, the department kept Veterinary Surgeon H. J. Detmers at the Chicago live-stock yards, examining cattle with the single view of ascertaining whether any trace of this disease could be discovered in that great depot for western cattle. This examination, which was made in 1879 and continued for some time, showed that it was unknown there. The market of Buffalo is in the State of New York, and therefore came directly under the examination of Prof. James Law, veterinarian-in-chief to the State of New York, whose particular business, under a special law, was to find and get rid of, so far as any means at his command would allow of its being done, this very disease—pleuro-pneumonia of cattle—and with the splendid system of detecting its existence in any cattle within the State, and with the great facility which he had for tracing any diseased animals that were found to their starting-point, he was never able, in any way, to locate the disease in Buffalo or at any point in the State within 400 miles, or thereabout, of that market. Neither has this department, although every means at its command has been tried, ever been able to find that it had any existence at any time nearer to Buffalo than the points indicated by Professor Law. Now we have in evidence that these animals passed for several hundred miles over the Grand Trunk Road. To do this and get to Portland after leaving Buffalo, they would not again enter the States until they had reached Vermont, where they cross a small portion of the extreme northeasterly corner of the State; thence across the extreme northerly portion of New Hampshire; thence for a short distance across the southerly portion of Maine to Portland; and at no time would they be nearer than Portland to the infected district, the nearest point of which is something over 300 miles away. It may be stated to a certainty that contagious pleuro-pneumonia of cattle does not exist in either Vermont, New Hampshire, or Maine. How, then, could these animals have become infected? So far as the territory through which they traveled on their way to the seaport lies within the United States, it can safely be said that no pleuro-pneumonia exists along, or anywhere near, their line of route. The cars in which they traveled could scarcely have been previously contaminated, for presumably they were those of this great northern trunk line, and would never be sent down into the neighborhood of New York, Philadelphia, or Baltimore for the conveyance of local cattle freight. The only way, then, would seem to be that the disease was contracted on board ship during the voyage. But ships that have carried cattle

are, on their return to Liverpool, required by law to be *thoroughly disinfected*, so that unless the Ontario, on her out voyage, brought to this country from England cattle affected with contagious pleuro-pneumonia, she could scarcely convey it to other and hearty beasts on the return trip.

That pleuro-pneumonia did exist among these cattle we have the evidence of, first, Mr. Moore, the inspector, who discovered it; second, that of Professor Duguid, who was sent down from London for the express purpose of inspecting this cargo; third, that of Professor Walley, who came from Edinburgh for the same pourpose, all of them gentlemen who are particularly well qualified to judge of the matter and give a valuable opinion regarding it. But it certainly does seem that Professor Duguid and Mr. Moore were undoubtedly mistaken as to the lungs condemned by them in my presence last July and August. May it not be that pleuro-pneumonia *contagiosa* is, after all, not so distinctive in its appearance as has always been supposed, or rather that changes are produced by certain other diseases, the lesions of which resemble so closely those of contagious pleuro-pneumonia that in the absence of any history of the animal would require a much more careful examination to detect its difference than veterinarians have heretofore supposed to be necessary?

The other gentleman, Professor Walley, says that he should judge that these animals were giving the pathognomonic cough of pleuro-pneumonia, but that he examined them, and even with the thermometer (a most delicate aid in these cases) he could get no indication that amounted to a sign that they were diseased; but still, *before he had finished his examination to his entire satisfaction*, he was called away to the slaughter-house, where he saw lungs removed from two beasts that to him presented "without any doubt the well-known lesions of pleuro-pneumonia." These lungs were marbled, and the parenchyma varied in color from deep red to pink, but it was mostly of a pinkish shade; that the largest diseased spot was as large as the crown of a derby hat; that there was no attempt at the formation of a cyst wall, because the disease had not been of sufficient standing; that the animals were in as good condition as any of the others, and that they had been selected haphazard from among the cargo in question. Is it not remarkable that although so large a portion of lung was affected there was no sign or symptom by which the animal could be selected out from among the others, which, on the testimony of this gentleman, showed no sign that "amounted to anything" of their being diseased, and that the only way of finding its presence was by a critical examination of the lung itself after the animal had been killed? Was ever such a case of acute contagious pleuro-pneumonia with this amount of lung implicated heard of before? I think not; and still this gentleman, who has had great experience with this disease, who knows that in Edinburgh the existence of "pleuro" is generally discovered by an examination made of the live animals in the byre, and not of the dead ones made in the abattoirs, and before he has had sufficient time to finish his examination to his own entire satisfaction, says that without a doubt these animals were affected with contagious pleuro-pneumonia! Now, I submit, are there not in this *evidences* of a huried examination? Has it not obviously been taken for granted that the detection of contagious pleuro-pneumonia, *post-mortem*, was a thing requiring a knowledge only of a most superficial sort? And I ask the authorities in this case if, in view of all the facts, it is not possible, nay, even probable, that a disease of not a sufficiently pronounced character to interfere with the well-doing of these animals may exist that shall give to the naked eye, upon examination of the lung *post-mortem*, the exact appearances of contagious

pleuro-pneumonia, but which is not that disease, but the result of some chronic process, the nature of which, in the absence of all history of the animal, may require a most careful and minute examination to detect its real differences?

The only gentleman engaged in the affair who seems at that time to have been of my present opinion, and to have realized its importance, is Professor Williams, of Edinburgh, who was called to Liverpool in precisely the same manner as was Professor Walley. This gentleman, who spent more time in the examination, who has had at least as large an experience as have any of the others, said, when he had finished the examination in Liverpool and was asked for his opinion, "I have as yet no opinion to give, and shall have none until I have been able to make a more thorough examination of the lung." For this purpose he took with him to Edinburgh portions of the lung, and he received from Mr. Wellsby, a veterinary surgeon in the employ of Messrs. Warren & Co., the steamship owners, for the next six months, portions of the diseased lungs which were condemned by the inspector at Liverpool, all of which received a most careful examination by himself and Dr. Hamilton, pathologist to the Royal Infirmary, and demonstrator of morbid anatomy in the University of Edinburgh, and after all this he declares that he has "not the slightest hesitation in saying that in no case has he found them to exhibit the characteristic lesions of contagious pleuro-pneumonia." Therefore it seems to me that there is, *at least*, fair reason to doubt whether the disease noticed among this cargo of the Ontario was really contagious pleuro-pneumonia. I have not gone into the discussion of this question in any captious spirit of criticism, neither do I mean for a moment to call into question the professional ability of any of those gentlemen, which I believe to be of the highest quality, and I most thoroughly believe that their decisions were given in accordance with their honest convictions; but if these convictions were arrived at too hastily, and before proper, and, in view of the gravity of the question, sufficiently exhaustive examinations of the facts were made, it is certainly my privilege to comment upon them, and show, if possible, that it was so. And if any statement or argument that I have advanced seems to be of sufficient consequence to really throw a doubt upon the decision of the authorities of Great Britain in this matter, I would most respectfully suggest that in fairness to the great interests of the United States, which are by this decision very severely prejudiced, that the judgment should at least be reconsidered.

My own opinion, arrived at after a most thorough and careful investigation and consideration of the facts, is that the lungs which were condemned by the inspector of the privy council at Liverpool during my stay there in parts of July and August last, as being affected with contagious pleuro-pneumonia, were in reality not affected with that disease. And further, I do not believe that a single case of contagious pleuro-pneumonia has ever existed in the West or has been landed in England from our ports of Boston or Portland, unless, indeed, it may have been communicated to the animals after they were placed on board the ocean steamer, from previous contamination of the vessel, by transportation in it of diseased animals from Great Britain to America, an event which I must say that in the case of pleuro-pneumonia I think to be very unlikely.

Respectfully submitted.

CHARLES P. LYMAN, F. R. C. V. S.

APHTHOUS FEVER, OR FOOT-AND-MOUTH DISEASE.

The technical synonyms for this disease are: *eczema epizoötica, aphthis pecorinis.* The English: *epizoötic aphtha, aphthous fever, vesicular epizoötic, murrain, epizoötic eczema.*

Reliable evidence is on record of the prevalence of this disease in Europe as far back as the seventeenth century. It was then noticed as frequently prevailing widely in Germany, Italy, and France. It did not make its appearance in Great Britain until 1839, where it quickly spread over the three kingdoms. The most observant writers state that it is an altogether exotic disease in the west of Europe, and always approaches from the east. Dr. Fleming says that it was introduced into Denmark in 1841, and into the United States from Canada in the bodies of cattle sent from England, but he fails to give the year in which it was introduced into this country.

Immediately upon the receipt of the report of the veterinary department of the privy council of Great Britain to the House of Lords in June last, in which the statement was made that a cargo of sheep suffering with this malady had been landed at Liverpool direct from Boston Harbor, a circular was prepared and forwarded to all the correspondents of this department, asking for such information as they could give touching the prevalence or non-existence of the disease in their various localities. In order that correspondents might be able to readily identify the affection, a brief statement of the symptoms was given in this circular letter. Out of some two thousand letters forwarded but few replies were received indicating the possible existence of the disease in this country. However, in view of recent condemnations of American cattle by the veterinary inspector of the privy council of Great Britain, for the alleged existence of foot-and-mouth disease among them, the Commissioner of Agriculture directed Mr. L. McLean, M. R. C. V. S., to visit and examine all suspected localities. After a most thorough and searching examination of animals upon many farms, in a number of feeding and distillery stables, and in the great cattle marts of Chicago, Saint Louis, and Kansas City, he states that he was unable to find a trace of the disease, as will be seen from his report contained in this volume.

As stated in the circular letter above referred to, aphthous fever, or foot-and-mouth-disease, is a contagious eruptive fever, attacking cloven-footed animals. It is also communicable to other warm-blooded animals, including even man. It is not known to have a spontaneous origin, but is believed to be communicated only by contagion. This contagion does not seem to be readily spread by means of the air, a stream of water or common road generally being sufficient to limit it. No poison, however, seems to be more certainly transmitted by contact, direct or through the medium of human beings, tame or wild animals, fodder, litter, manures, clothing, drinking-troughs, &c. Milk is regarded as one of the most frequent sources of contagion to pigs, dogs, and even to infants. The disease is not a very fatal or destructive one, and the most serious damage sustained in the case of milch cows is in the loss of milk; the

udders become inflamed, the teats blind, and when the affection extends to the feet a serious lameness intervenes. The animal frequently becomes quite vicious, and is useless for dairy purposes. The average loss of flesh is from five to ten dollars per head among cattle; in dairy cows it is much more. The contagion has a duration of about fifteen days. No permanent ill consequences remain, especially if the animal has been well cared for during the progress of the malady.

The disease is principally confined to cattle, sheep, goats, and hogs, though deer, wild hogs, horses, dogs, poultry, and even human beings have been known to suffer from the contagion. The order of susceptibility to receive the infection may be stated thus: Cattle, sheep, goats, camels, pigs, deer, rabbits, hares, mankind, fowls, dogs, and horses. It affects the skin and mucous membranes, and is charcterized by an eruption of small vesicles, either confluent or isolated, on the lining membrane of the mouth, rarely extending beyond the mouth internally and the interdigital space (seldom the nostrils) of bisulcate animals. The eruption may appear in both of these situations in the same animal, or only in one; in certain outbreaks, or in certain species, one of the regions is more frequently affected than the other. The eruption is observed only in the mouth of a horse suffering from the contagion. In bovine animals the eruption or vesicles frequently appear also on the udder and teats. In sucking animals unmistakable traces of the disease may sometimes be found in the larynx, pharynx, stomach, and intestines. Plate I illustrates the appearances of the vesicles or eruptions, both isolated and confluent, as exhibited on the nose, lips, tongue, gums, &c., of an ox suffering with the malady.

CAUSES.

The causes which originally develop the malady are unknown. It generally appears in an epizootic and rarely in a sporadic form; in certain years it becomes widely extended, invading whole countries, progressing from the east towards the west of Europe. Its extension seems due to its contagious properties alone and the facilities offered for the dissemination of the virus.

As in most other contagious diseases, there are seasons or years in which the malady is much more virulent and malignant than in others. On the continent of Europe it has been observed that these malignant seasons have generally been accompanied or preceded by extensive invasions of anthrax. In Russia it has frequently been observed to be coincident with contagious pleuro-pneumonia, or lung plague of cattle. Veterinarians are of the opinion that individual conditions likewise seem to have some influence in predisposing the organism to its invasion or severity. Among these are enumerated fatigue, bad hygiene, pregnancy and parturition, emigration from one locality to another, lactation, and indifferent, damaged, or sudden change of food.

SYMPTOMS IN CATTLE.

As before stated, this affection is characterized by an eruption of vesicles, or blisters, in the mouth, and on the internal surface of the lips, sometimes in the nostrils, and on parts of the body where the skin is thin and least covered by hair, as on the udder and between the claws. It passes through different phases, and is described under four different periods by Fleming, viz: Fever, eruption, ulceration, and desiccation. The symptoms of the disease are thus described under these four distinct periods:

First period.—Before any perceptible alteration has taken place in the ordinary habits or condition of the animal, the thermometer indicates an increase of temperature, which gradually ascends to 102°, and as high as 104° or even 107° F., in from one to two days, and does not descend to any extent until the end of the eruptive period. The next indication is dullness, inappetence, and slight shiverings. The muffle becomes warm and dry; the eye is tearful, and the mouth hot and inflamed-looking in places, and frequently sore when handled; the membrane being covered with viscid mucus, which flows in stringy masses from the lips. There is grinding of the teeth, and a smacking or clicking noise; the breath has a fetid odor; rumination ceases, and the prehension and often the deglutition of food is painful, the animal preferring to dabble its mouth in cold water. Not unfrequently, when the feet are beginning to inflame, the animal stands uncomfortably, drawing the limbs together, standing uneasy, or jerking them up suddenly under the body, arching the back, and pawing; the movements are reluctantly performed, and the coronets hot and sore. There is also slight constipation, and, if it be a milch cow, the secretion of milk is gradually diminished, and that fluid assumes a yellow tint; in the majority of cases it is nearly or altogether suspended. The udder becomes red and tense when it is involved, and the teats swollen and painful to the touch. This stage usually lasts from twenty-four to forty-eight hours, according to the intensity of the fever.

Second period.—After the time above mentioned, the eruption begins to appear in those parts which are to be its seat, and the fever commences to abate in many cases. When the mouth is chiefly affected, there are seen on its lining membrane, and particularly on the upper lip, gums, and sides of the tongue and palate, white, or yellowish white, blisters, the size of a grain of millet to that of the size of a pea or nut, their form being very irregular. (See Plate I.) Sometimes they are discrete, or scattered over the surface; in other cases they are confluent, collectively forming patches which are at first gray or yellow, and afterwards white; slightly convex; each vesicle is usually circular: the smallest are seen on the muffle. In the mouth they are largest, and most frequently confluent; but there they only exist for a brief period, the friction caused by the movements of the tongue tearing them; the epithelium is detached in flakes of variable dimensions, leaving unhealthy ulcers or denuded spots, or "erosions" of a bright-red tint, which contrasts markedly with the gray hue of the surrounding surface. These shreds are often seen adhering to the border of these sores; and if on the tongue, that organ is kept continually moving to get rid of them, and the animal emits a smacking sound with its lips. Where there is no friction the vesicles do not rupture within one or two days. On the udder the vesicles are somewhat different. The teats are most frequently their seat, and it is not unusual to find the phlyctenæ grouped in a circle around their orifice; when isolated on the surface of the organ they are surrounded by a pale-red circle, and when confluent they are very irregular and variable in number. In the case of a cow the alteration of the milk is very striking.

When the limbs are affected, the heat and redness of the coronet are most noticeable toward the heel and interdigital space of one or more feet. The coronet swells; the animal is lame, and prefers to maintain a recumbent position. In one or two days the vesicles are developed at the points indicated, most frequently earliest in front of the interdigital space; at first they are small, but they increase in size until they are as large as a bean, or small nut, and extend around the claws, often becoming confluent, the contents appearing as a yellow limpid fluid. The skin of the part assumes a bleached aspect, and is soon covered by a kind of cheesy matter, resulting from the inspissation of this fluid, which emits an ammoniacal odor.

In some cases, the skin around the base of the horns becomes inflamed at the same time as that of the mouth or feet, and the horns are loosened. Occasionally, also, a vesicular eruption manifests itself at the orifice of the vagina, at the perineum and anus, or in the nostrils; and it sometimes happens that the eyes are affected, the conjunctional membrane becoming inflamed and suppurating, and phlyctenæ forming on the cornea. There may also be nasal cataarh and symptoms of gastric derangement.

Third period.—This is the aphthous stage of the disease, and begins when the vesicles have ruptured, and, the epidermis being removed, erosions appear. This does not occur everywhere at the same time, but varies according to the region. In the mouth it soon occurs, owing to the movement of the tongue, and also in the feet by that of the claws. On the udder it is later, seldom occurring before thirty-six or forty-eight hours; or if the disease is benignant the vesicles on this organ may not rupture at all, their contents becoming absorbed, and the pellicle of epidermis covering them scaling off when cicatrization has taken place beneath. When the vesicles do break, there remains a little bright-red sore, which is smooth or granulating, and is soon covered with a fluid pus or yellow exudate of epithelial cells, which, in drying, forms a thin reddish crust that protects the erosion until it heals.

In the mouth and on the lips the vesicles are broken almost as soon as formed, leaving circular or irregular bright-red sores, which bleed readily, their rupture being indicated by dribbling of saliva streaked with blood. It sometimes happens that when

the tongue is seized to explore the mouth large patches of epidermis come away in the hand, as if the tongue had been boiled. In some rare cases an exudation of yellow color and cheesy consistency is observed toward the root of the tongue, due to epithelial proliferation.

The fever has greatly subsided, but the thirst is intense, and the animal eagerly drinks water or gruel, though owing to the soreness of the mouth it can eat but little, especially if the food be dry and hard, consequently the loss of condition is rapid.

Fourth period.—This is marked by the desiccation or drying up of the aphthæ, and the formation of new epidermis. The crust falls off, and the new epidermis or epithelium appears as a thin lead-colored pellicle. With the completion of this process all traces of the disease disappear. There is no lameness, the appetite has returned, and the former condition is being restored; while the secretion of milk, which may have been greatly diminished—perhaps to less than one-third—becomes augmented, and regains its normal properties.

SYMPTOMS IN SHEEP AND GOATS.

The fever is not so marked in these animals, though in some instances the temperature may rise as high as in the bovine species. The patient seems weak and dull, lies apart from its companions, and can only be made to rise with difficulty. A smacking sound is made with its lips, which are kept moving as in the act of sucking. The mouth is hot and filled with viscid saliva. The vesicles in the mouth form chiefly on the incisor pad, and the eyes as well as the vaginal membrane may be involved. Fleming states that in these animals the eruption is more frequent on the extremities than on the mouth, but that the formation of vesicles is not very common. More frequently the skin around the claws and in the interdigital space is swollen and more or less red, and from its surface a fluid escapes which, in drying, gives rise to crusts. The inflammation in this region often runs on to suppuration, involving, sometimes, the biflex canal, or producing disunion of the hoofs. If proper precautions are not taken in such cases the disease may assume a very serious form. As in the case of cattle, the loss of condition is more or less marked.

SYMPTOMS IN SWINE.

In swine affected with the disease the eruption in the mouth is rare, that of the feet being most common. The nose and the parts adjoining show the affection when the mouth is involved. The symptoms differ but little from those exhibited by other animals suffering with the disease. The feet are liable to take on a high degree of inflammation. Progression, therefore, causes intense pain, and there appears to be a great tendency to shedding the hoof. If the patient is a sow the udders are implicated as in the case of a cow.

SYMPTOMS IN THE HORSE.

In the horse the early symptoms of aphthous fever are similar to those manifested by the cow when the lesions are in the mouth. "There is fever, the lining membrane of the mouth is hot, red, and covered with a quantity of viscid stringy mucus, while mastication is difficult, and the horse loves to lave its mouth in water." Vesicles, the size of a grain of millet, appear on the inner surface of both lips at the mucous glands. These soon increase to the size of a pea and are filled with a transparent serum. They soon rupture, leaving erosions that are quickly covered with new epithelium. If there is but one eruption of vesicles the disease will pass through all its phases within from seven to ten days; but if there should be a succession of these eruptions the attack may be prolonged two or three weeks. In such cases the animal becomes greatly emaciated.

SYMPTOMS IN BIRDS AND FOWLS.

Birds suffering with the malady show the eruption in different regions. In fowls the vesicles appear more particularly around the nasal openings and on the crest, though they are also seen in the mouth and nostrils. Geese are principally affected on the membrane of the interdigital spaces.

NO IMMUNITY BECAUSE OF PREVIOUS ATTACK.

One attack from aphthous fever affords no protection from a second, third, or even a fourth attack, as animals remain susceptible after being affected several times. Cases are on record of where an animal has suffered as many as five times from the disease, and one cow is reported to have had two attacks in one month. Some veterinarians are of the opinion, however, that animals that have once suffered with the disease are not liable to suffer as severely as those that have never been affected.

COURSE AND TERMINATION.

Under good conditions of hygiene and careful nursing, this fever runs its course, without any very serious constitutional disturbance, within from eight to fifteen days. Convalescence is generally very slow, but is much more so under unfavorable conditions, such as improper care, bad treatment, indifferent hygienic measures, a lack of proper ventilation, &c. Under these conditions the disease may assume a very serious and painful character, by the inflammation in the feet extending to the vascular tissues covered by the hoof, and the formation of dangerous abscesses, of a white color, which can be distinguished under the horn covering them. These abscesses may find an outlet at the coronet; but in cases of neglect this matter may form sinuses and cause the hoof to detach, destroy the ligaments and joints, and ultimately lead to the destruction of the animal. Fleming says that the udder, in case of cows suffering with the disease, may also become the seat of abscesses or induration. In such cases the eruption extends to the intestinal mucous membrane, and to sucking calves, thus drawing their nourishment, this condition is particularly dangerous, as the intestinal canal generally becomes the seat of the eruption. Severe fever, fetid diarrhea, swelling of the head, great prostration, and the death of the young animal soon follows. The appearances in the intestinal canal resemble somewhat the lesions in cattle plague, and this form has been named by European veterinarians the typhoid complication of aphthous fever.

PATHOLOGICAL ANATOMY OF THE DISEASE.

Fleming, in his work on Veterinary Sanitary Science and Police, gives the following pathological appearances of the disease:

> The pathological anatomy of the disease in mild cases is very simple, consisting only in the elevation of the epithelium or epidermis by the limpid fluid that forms the vesicle, and which, by its accumulation and the softening of its envelope, causes the rupture of the latter. The aphtha remaining is very superficial under ordinary circumstances, and in the mouth especially; on the feet, however, the erosion is usually deeper, and in the interdigital region of the sheep frequently becomes a deep ulcer that may cause the disease to be taken for foot-rot. In cattle also, owing to movements constantly taking place, the aphthæ and their accompanying inflammation may destroy the skin, involve the textures beneath the hoofs, lead to loss of these, disease of the ligaments and ultimately of the bones.
>
> Aphthæ and vesicles may also be found on the palate, in the pharynx, and on the mucous membrane of the true stomach and duodenum. In the two last, they more frequently appear as sharply defined ulcers in the middle of the discolored patches. The mucous membrane of the intestines may also be reddened, and marked by hæ-

morrhagic spots; Payer's patches and Brunner's glands partaking of an ulcerous character.

Serous and sanguineous infiltrations have been found among the muscles; but these have been attributed to the fatigue the animals experienced in traveling to the markets. * * * The saliva, when carefully gathered and examined, is perfectly pellucid, contains small stellate crystals, and minute spherical bodies or monads, the latter possessing great activity of movement. In the fluid of the vesicles are large nucleated cells and masses of living germinal matter, besides monads, bacteria, and vibriones. The fluid discharged from the eyes appears to contain similar bodies.

The milk has been found of low specific gravity (1024), though it generally yields a moderate proportion of cream. Large granular cells, or white corpuscles, having the general character of pus globules, were constant and present throughout the whole course of the disease, and even for some time after recovery, though they were most numerous during the height of the malady. Monads and bacteria were also observed, and boiling did not affect their form or movements.

CHARACTER OF THE CONTAGIUM.

According to the opinions of the best German authorities, the contagium of this fever is both "fixed" and "volatile." Some French authorities deny the volatility of the contagium, and contend that it is fixed. This disagreement between eminent authorities leaves this point in doubt, therefore it would be safest to assume that both German and French authorities are correct. Whether volatile or not, the contagium seems to exist in its most concentrated form in the lymph or serum of the vesicles, and in the saliva; but this is not its exclusive vehicle, as other products of secretion, such as the milk of living and the blood of dead animals contain it. In all probability it is present in the volatile as well as in the fixed condition in the excretions. In the first stages of the disease it may not be transmissible in a volatile form, but the evidence would seem to favor such a transmission after the formation of vesicles, and this condition remains until the febrile stage has passed and the vesicles have dried and cicatrised.

VITALITY OF THE VIRUS.

Many of the writers on the subject of aphthous fever give cases showing the vitality of the virus. Rosenkranz says that four weeks after the disappearance of the disease the excrements of infected animals caused an outbreak in a team of oxen employed in carrying it away from the farm and plowing it into the ground. In another instance, given by Haubner, three months after the extinction of the malady in a district, two calves were brought to a manor-house, and ten days thereafter the disease appeared. Fundel has known instances in which the disease has been communicated in infected stables after they had remained vacant for fifteen days. He also states that he has known the virus to be preserved for a long period in forage, although this had not been impregnated by saliva from the disease, but only exposed to the atmosphere of the stable they had inhabited. The outbreak of the fever in Australia in 1872 is said to have been due to the importation of an animal from Britain which exhibited no symptoms of the disease during the voyage. In this case the virus was believed to have been retained in the last truss of hay given to the animal, which sickened therefrom as it entered the harbor at Sidney.

MODES OF INFECTION.

It is a pretty well established fact that the disease is not able to infect at a very considerable distance. Fundel, an authority above quoted, believes that the contagion can be communicated at a distance of 100

meters. Where the disease prevails to any great extent roads are a fruitful source of infection. Animals driven to fairs or to market, it compelled to pass over roads traveled by animals suffering with the malady, are almost certain to become infected. Pasturing animals on commons is another fertile mode of spreading the disease. It is also diffused by means of the stables or lairs in the vicinity of markets. Animals are frequently lodged for one or more nights in such places, where they may meet diseased cattle, or where the infection from these may yet remain. Animals which have come in contact with those afflicted with the fever, even for a very short period, have subsequently infected others, though they themselves remained healthy. Others, apparently quite recovered and free from all symptoms of the disease, have been known to disseminate the contagion. Drinking from the same troughs and feeding from the same ground or out of the racks recently used by sick animals, is almost certain to transmit the contagion. Railway cars and cattle-ships are prolific sources of infection, and disseminate the disease over great distances. Forage impregnated with the saliva, litter on which cattle whose feet were affected have stood, and the clothing of people who have been about the sick animals, will all act as bearers of the contagion. Fleming says that the contagium may find access to the blood by the mouth, air-passages, or any other part where the mucous membrane is thin and vascular, as the generative organs. It may also be absorbed by the skin, as between the claws, as it is readily inoculable. Fowls will contract the disease by frequenting places where the ground or litter is soiled with virulent saliva.

The period of incubation is usually from three to six days after contamination, though it is known to have occurred within twenty-four hours, and in other cases to have been delayed as long as ten or twelve days.

SANITARY MEASURES.

Measures necessary to prevent the invasion or extension of this fever should be similar to those prescribed for other contagious maladies. When the disease appears in a locality, isolation and disinfection should be regarded as the principal measures to be enforced. All infected stables, as well as those immediately adjacent, should be carefully avoided until three weeks after the disease has disappeared. In the mean time all stables, sheds, and transportation vehicles in which infected and diseased animals have been confined should be thoroughly disinfected with carbolic acid or by burning sulphur.

CURATIVE MEASURES.

As a rule, Fleming says, few diseases are more amenable to treatment, and still fewer exemplify the beneficial effects of hygienic measures than this. In the revised edition of Clater's work a number of recipes are given for the amelioration and cure of the disease. In the simple eruptive form as soon as the vesicles are observed a drench composed as follows is recommended:

Take of epsom salts	8 ounces.
Ginger and gentian powdered, of each	2 ounces.

Mix these with one-half pound of treacle and a quart of strong ale and give to a large cow, &c.; three-fourths or one-half may be given to lesser animals and year-olds; one-third for calves up to eight or ten months old, and one-fourth for sheep. Large doses must be avoided, as

purgatives cannot be endured. The mouth should be washed twice daily with the following mixture:

Take of alum in fine powder	1 ounce.
Tincture of myrrh	1 fluid ounce.
Water	1 quart.

The healing action will be promoted and accelerated by opening the vesicles in the mouth with a knife or lancet. If matter forms in the neighborhood of the hoofs all detached portions should be carefully removed and the parts dressed daily with a mixture compounded as follows:

Take of tincture of myrrh	2 ounces.
Butter of antimony	1 ounce.

This should be mixed and applied to each sore by means of a feather or piece of tow placed upon a stick. If weakness supervenes, diffusible stimulants, such as ammonia, brandy, &c., must be given, in which a little ginger and gentian should be mixed. When the febrile symptoms prevail, small doses of the sulphate or nitrate of potash are usefully combined with tonics in the following proportions:

Take of sulphate or nitrate of potash	½ ounce.
Sulphate of iron	2 drachms.
Ginger	½ ounce.
Gentian	½ ounce.

Mix and give daily or twice a day, morning and evening, according to circumstances, in either porter or ale.

Maturation of abscesses should be promoted by the use of hot water, poultices, blisters, &c., and all suppurating surfaces should be kept clean by the use of such dressings as the following:

Take of chloride or zinc	2 drachms.
Tincture of myrrh	1 ounce.
Water	1 pint.

Or the following:

Take of crystallized carbolic acid	½ ounce.
Glycerine	6 ounces.

Dissolve this, and add—

Tincture of myrrh	1 ounce.
Water	1 pint.

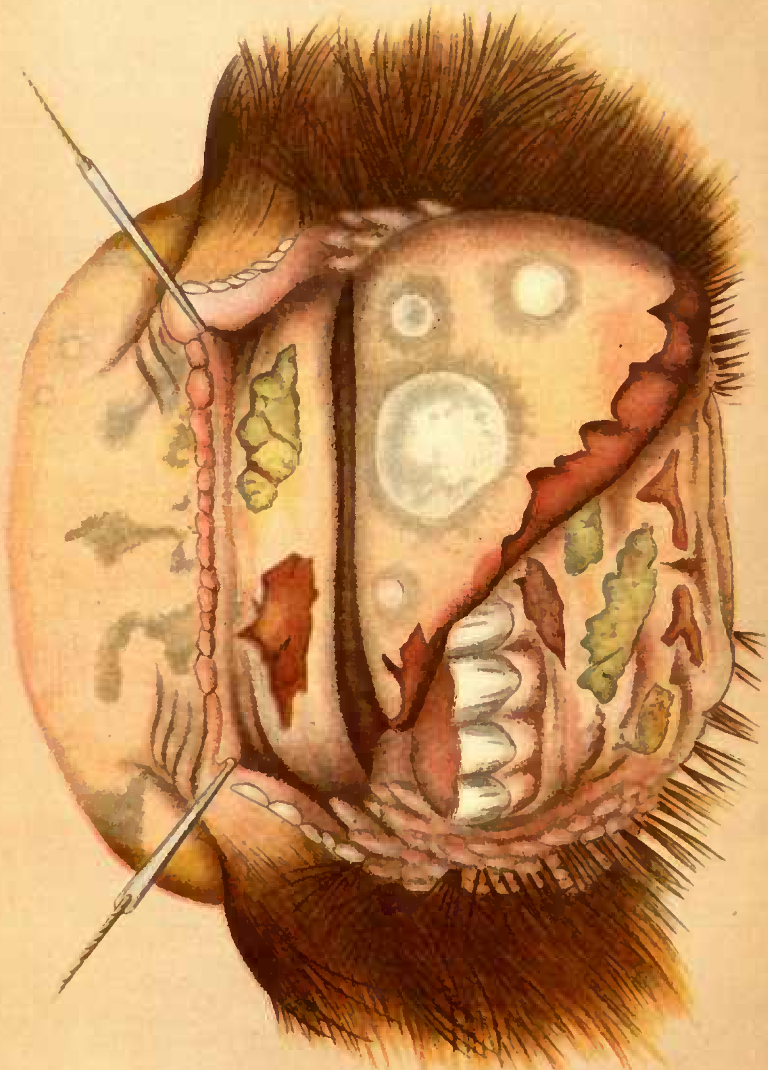
As a diet hay tea should be liberally provided as soon as the animal is able to take nourishment. Mashes of barley, malt, oats, with a little linseed to promote the proper action of the bowels are of absolute necessity. Green clover, grass, carrots, swedes, &c., or any other food easy of digestion, are recommended. Overloading the stomach, however, should be carefully avoided.

Cleanliness, good dry beds with proper ventilation of buildings, are necessary requisites. In order to protect the spaces between the digits from irritation, which frequently occurs from the insinuation of straws, dirt, &c., the feet should be bound up after proper dressing, by inserting a rag between the claws and fastening it above the coronets. In cases of affection of the udder, when the abstraction of milk is difficult and painful, the teat siphon should be used for emptying the gland. After the udder is relieved, the following solution may be injected with a glass syringe in order to neutralize the acidity consequent upon the morbid action within:

Take of carbonate of soda or potash	½ drachm.
Water	8 ounces.

FOOT AND MOUTH DISEASE.

Report Commissioner of Agriculture for 1880. Plate I.



The Mouth in Epizootic Aphtha.

A. Hoen & Co. Lithocaustic, Baltimore.

Mix and thoroughly dissolve this solution before using; one or two injections for each teat will be found sufficient.

If the udder is much inflamed, common elder ointment rubbed upon the outside is recommended. The extract of belladonna is also regarded as an efficient remedy. The following compound is given:

Take of extract of belladonna	1 ounce.
Hogs lard	6 ounces.

Mix by means of a spatula, and anoint the parts daily with as much friction as can be borne by the animal; indurations may be treated afterwards by iodine or mercural ointment.

As the symptoms of this disease are principally of an outward character, and can be readily identified, it is not deemed necessary to give the appearances of the lesions as shown in *post-mortem* examinations.

INVESTIGATION OF TEXAS CATTLE FEVER.

REPORT OF DR. H. J. DETMERS.

Hon. WILLIAM G. LE DUC,
Commissioner of Agriculture:

SIR: In the following pages I have the honor to lay before you my observations in regard to so-called Texas fever, of which a few cases (seven in all) occurred in September and October among the town cows in Champaign, Champaign county, Illinois. As my opportunities to study the disease by personal observation were limited to only four cases out of seven, I shall restrict myself to merely reporting the facts as I found them, and shall not offer any conclusions arrived at. Neither do I intend to make any attempt to cover the insufficiency of my own experience by drawing plausible deductions from the experience and observations of others, published in former reports of the Department of Agriculture, in the report of the Cattle Commissioners on Texas Fever in 1868, and in other reports, divers pamphlets, periodicals, &c., accessible to me or in my possession. Such deductions can be made in the study with a library at one's back, and do not require any actual investigation, but are after all mere opinions, and not facts.

On September 3, I learned that two town cows had died of the disease generally known in the West as Texas fever, in that part of the southern portion of the city of Champaign which is situated immediately west of the track and the cattle pens of the Illinois Central Railroad, Chicago branch. Going over there and inquiring further, I found a cow diseased with Texas fever in Patrick Monahan's stable, a few rods from the railroad cattle pens. The diseased animal was a young red cow of common breed, and in very good condition as to flesh, but already thin and gaunt in the flanks. She had shown plain symptoms of disease—had passed red urine—since the morning of September 2.

Symptoms.—The animal was lying down in an unnatural position, the horns resting against the manger. The muzzle dry and moderately hot; horns rather cold, and of changeable temperature; visible mucus membranes pale; breathing laborious; excrements thin and voided in very small quantities; urine, which was passed quite often, and at brief intervals, of a deep red-brown color. The animal showed great indifference to surroundings, but was very restless; she tried several times to get up, and though apparently not lacking muscular strength, did not seem to have sufficient control over her motary apparatus, and several times broke down in the attempt, and then made no effort to correct the unnatural position in which she sank down. Finally she succeeded and got on her legs, soon to break down again, after she had staggered a few steps and passed water, when her want of control over the voluntary muscles became still more apparent.

September 4.—A cow died at 4 o'clock a. m., and the *post-mortem* examination was made at 10 o'clock a. m., or about six hours after death.

Morbid changes.—Externally nothing remarkable except that the muscles presented a bloodless appearance similar to those of a slaughtered animal after the skin had been taken off. On cutting the axillary artery and vein and removing the shoulder, so as to give better access to the chest, only a drop or two of pale blood, mostly serum, flowed off. Internally, the lungs healthy, and no morbid changes in any organ of the chest, except a considerable quantity of reddish serum in the pericardium. In the abdominal cavity, the liver considerably enlarged and presenting an abnormally dark color; the spleen over four times its normal size, and on cutting into it an almost black and grumous-looking substance (blood) oozed out; numerous ecchymoses in the large intestines; kidneys dark and congested, presenting extravasations of blood; bladder full of dark-brown urine, which, although perfectly clear and transparent, proved to contain, when subjected by Professor Weber, of the Illinois Industrial University, and myself to chemical tests, large quantities of albumen.

On September 6, late in the evening, I received word from Mr. Monahan that his other cow had passed red-colored urine on Sunday. I went over and found the cow, a large red-and-white milch cow, heavy with calf, in good condition as to flesh, lying in a perfectly natural position in an alley near Monahan's house. The cow, when approached, arose and stretched herself, and when a dog came along she attacked and drove him off. Her muzzle was moist and cold, and no symptoms of disease could be observed; still it must be stated that the night was rather dark, and the light given by the lantern used was dim and flickering. Being unable to go to Monahan's the next day, and not considering the cow very sick, I went there on September 8, at 10 o'clock a. m., and found her in the stable lying down with the hind quarters in an unnatural position, almost doubled up. Visible mucous membranes pale; muzzle dry; horns and extremities cold; temperature in rectum 101° F. The animal appeared to be indifferent to surroundings, but was not as restless as the first cow. Made another visit in the afternoon and found her lying down in a more natural position. She had just been drenched by the owner with some mixture or decoction, a part of which, it seems, had passed down the windpipe into the lungs; at least the animal repeatedly coughed as if something of that kind had happened. The urine, flowing off in my presence, was of a dark-red color, but perfectly clear, uniform in color, and without any perceptible sediment.

September 9.—The cow died at about 4 o'clock a. m., and the *post-mortem* examination was made at 8 o'clock a. m. When the skin was taken off, the flesh was not quite so destitute of blood as that of the first cow, which died September 4, but was also nearly bloodless, and resembled that of a butchered animal. A few drops of blood were collected from the jugularies when the head was cut off.

Internal morbid changes.—The lungs large, not collapsed, somewhat congested, and in the tip of one lobe some incipient hepatization, due undoubtedly to the fact that medicine had been poured down the windpipe into the lungs. The owner admitted that the cow had been drenched several times since she showed the first symptoms of disease, and that nearly every drenching had been followed by a violent fit of coughing. The heart, and everything else in the chest, was found normal. In the abdominal cavity the spleen considerably enlarged (see photograph, plate I), but not near as large as in the other cow. Purplish-black

blood oozed from a small cut (presented in photograph), the same or similar in appearance as that of the spleen of the first cow. The liver about three times its natural size, and exceedingly heavy and brittle; gall bladder very large and full of bile; congestions and erosions in the fourth stomach; kidneys congested, but not otherwise of abnormal appearance, and the urine, of which the bladder contained a large quantity, of a red-brown color, but perfectly clear and transparent. The attack of this cow had been decidedly milder than that of the former; her sickness lasted one day longer before becoming fatal, and death probably would have ensued still later if no medicines had been poured into the lungs.

September 10.—Received word that another cow, belonging to Mrs. Harris, who lives in the same neighborhood with Mr. Monahan, had become affected. I went there at 9 o'clock a. m., and found a fine large cow in the last or paralytic unconscious stage of Texas fever. The head was swelled, the eyes almost closed; the surface of the body rather cold to the touch, and the temperature in the rectum 100°6 F. The muzzle was dry and the visible mucous membranes very pale. Some dung, which had passed a few minutes before my arrival, was dark-colored and mixed with streaks of blood. The cow was lying down in an awkward and rather unnatural position and unable to rise. Called again at 1 o'clock p. m., and found the animal dead; she had died a few minutes previous.

Post-mortem examination was made about one hour after death, or immediately after the cow had been hauled out of the city limits to a piece of ground belonging to Mrs. Harris.

Morbid changes.—Externally a few bruises on the left side of the body; the meat bloodless, as in Monahan's cows, and presenting an appearance of death caused by bleeding. Internally, all organs in the chest healthy. In the abdominal cavity, the liver enlarged, of a deep mahogany color and gorged with blood; the gall bladder large and full of bile; the spleen about three times its natural size and full of dark-colored blood; the third stomach impacted with dry food and presenting the appearance of a hard and solid body; ecchymoses and congestion in the fourth stomach and large intestines; the kidneys congested and the urine bladder containing a large quantity of brownish-colored but transparent urine, which, like the urine of the two cows of Mr. Monahan, proved to consist largely of albumen.

October 3.—Learned in the morning that another cow, belonging to Mr. Ritschener, who lives next to Mr. Monahan, died of Texas fever. I went there at 9 o'clock a. m., and found a two year-old heifer, in a first-rate condition as to flesh, lying dead in the corner of an empty lot, to which the carcass had been removed by Mr. Ritschener. The *post-mortem* examination was made immediately. The carcass was very fat, and the flesh, where not already decomposing, presented the clean and bloodless appearance of the meat of a butchered animal.

Internal morbid changes.—None in the chest; the liver much enlarged, gorged with dark-colored blood and very brittle; the spleen also two or three times its normal size, and when cut into a blackish, grumous-looking, and very offensive smelling fluid (decomposing blood) oozed out; kidneys somewhat enlarged but flabby and lacking that solid appearance of those organs when healthy. The urine bladder was found empty, but a reddish-colored urine dripped off out of the vulva while the skin was being taken off. As the animal had been dead nearly twenty hours, according to Mr. R., the intestines were in a state of decomposition, and therefore not opened. The third stomach, however, was not impacted,

and no morbid changes of any consequence were externally visible, or if existing were hid by putrefaction changes. It should be mentioned that some serum was found in the pericardium and in the abdominal cavity.

THE ORIGIN OF THE OUTBREAK.

Seven town cows died, all of which were owned by people living in the immediate neighborhood of the cattle pens of the Illinois Central Railroad. The first cow that died belonged to Mr. Crockett; she was taken sick on August 28, and died, as I have been informed, on August 31. The second, which belonged to Mr. Ritschener, took sick on August 31 and died September 2. Mr. Monahan's red cow, the first one examined, and the third one that died, showed the first symptoms of disease on September 2, and died, as above stated, on September 4, early in the morning. Mr. Monahan's red-and-white cow, the second one that was examined, was the fourth that died, and was sick four days; she died, as stated, early in the morning September 9. Mrs. Harris' cow, which died September 10, was the third one examined and the fifth one that died, after having been sick two days. A cow belonging to a tailor, whose name I neglected to take, was the sixth, and died in the latter part of September, after having been sick two days. Mr. Ritschener's heifer, which died October 2, was the fourth animal examined, and the seventh and last one that died; she was sick about two days according to the information received. All these animals, together with a very old cow which belongs to Mr. Monahan, and is the dam of the red-and-white cow, the second one examined, had been seen in the cattle pens of the Illinois Central Railroad, which, as a rule, were always open when not occupied till September 7, and contained some old straw, &c., and some manure left there by cattle which had been shipped or unloaded from the cars. It was further ascertained that some time in July or August—I was not able to learn the exact date, for nobody seemed to know or be willing to tell the same—a car loaded with Texan cattle on its way to Chicago broke down at Champaign, or at any rate became so damaged as to necessitate the unloading of the cattle at the cattle pens; and the owners of the town cows which died, and others living in close proximity to the cattle pens, claim that that car load of Texan cattle contained one diseased cow. This is all that could be learned of the source of the outbreak. If compared with what is known about the peculiarities of Texas fever, comment will not be necessary. It may be said, however, that of all the town cows that were seen in the open cattle pens of the Illinois Central Railroad, only one, Monahan's old cow, did not contract the disease, while all others became infected and died.

As nothing definite could be ascertained regarding the exact date at which the Texas cattle were unloaded, and as the cows visited the cattle pens undoubtedly oftener than once, nothing can be said in regard to the length of the period of incubation. Only this much is certain, that Mr. Ritschener's heifer which died October 2, and the cow which belonged to the tailor and died in the latter part of September, did not become infected after September 7, because after that date the cattle pens were kept locked.

EXPERIMENTS.

As only seven cows became diseased and died, and as only three of those seven were examined during life and four after death—the other cases did not come to my knowledge until after the carcasses were

buried—and further, as the cold season was close at hand, I had not much chance to make experiments, except by feeding some of my experimental pigs (kept for experimentation with swine-plague) with some of the morbid tissues of the dead cattle. I repeatedly gave large pieces of liver, spleen, kidneys, &c., to two of the pigs, but particularly to experimental pig No. 3, a healthy sow pig about ten or eleven months old. She received large pieces of liver, spleen, and kidney on September 5, 9, and 10, and October 3. She greedily devoured them in my presence, but her health was never disturbed, and up to date nothing has happened.

MICROSCOPIC INVESTIGATION.

1. *The blood and blood serum of Monahan's red cow, which died September 4.*

a. The blood of the spleen examined September 4, while yet perfectly fresh, and without any fetid or putrid smell whatever, presented the following: All red blood corpuscles apparently normal; a few white blood corpuscles and numerous micrococci, single and united in very large zoöglœa, but no rod-shaped forms of schizophytæ (bacteria or *bacilli*).

b. The serum of blood which oozed out of the liver on an incision contained no blood corpuscles whatever, notwithstanding its blood-red color, but numerous very large rod-shaped schizophytæ of the genus *Bacillus* (see drawing No. I), and a great many micrococci. The *bacilli* plainly jointed, forming joints while observed under the microscope; on some of those in motion flagella could be seen, provided the motion was not too rapid. The serum contained also epithelium cells, and numerous large zoöglœa (not represented in the drawing). An hour later all the large rod-shaped forms (*bacilli*) in motion, and the flagella seen on many of them. All seem to have a slight reddish tinge even if accurately focused.

A third examination was made on September 5, after the blood of the liver, which had been kept in a so-called homeopathic vial, had become slightly putrid, but no *Bacteria termo* could be found.

The urine of the same cow obtained on September 3, while the animal was yet alive, and examined one hour after it had been passed, contained a few blood corpuscles and numerous large *bacilli.*

2. *Mr. Monahan's red-and-white cow, which died early on the morning of September* 9.

a. The blood of the spleen, that is, such as oozed out when that organ was cut into (the cut is shown in colored photograph of Plate I), was dark colored, somewhat thick, and of a grumous appearance. Examined microscopically on the same day, it presented an immense number of normal red blood corpuscles, comparatively few white cells, and numerous micrococci. Diluted with distilled water, very large zoöglœa masses, and numerous micrococci, which had been hid from view by the dense mass of blood discs, covering the whole field, became visible.

b. The blood taken from the jugularis, and examined the same day, presented the blood corpuscles, at least most of them, more or less crenated, and contained zoöglœa masses and many micrococci (*cf.* drawing No. III, *a*).

c. The blood of the liver, which oozed out when that organ was cut into pieces, was also examined the same day, and found to contain normal blood cells and numerous micrcoocci. Drawing No. III, *b*, represents its appearance when examined next day.

3. *The blood and urine of Mrs. Harris' cow.*

a. The blood of the posterior vena cava, caught directly from that vessel in a small so-called homeopathic vial at the time the *post-mortem* examination was made, contained—examined under the microscope on the same day—crenated blood corpuscles and numerous micrococci (*cf.* drawing No. IV).

b. The blood of the liver, obtained by cutting into that organ, and examined at the same time (September 10), contained crenated blood corpuscles, immense numbers of micrococci, and zoölgœa masses (*cf.* drawing No. V).

c. Blood of the spleen, such as oozed out of that organ when an incision was made, contained most of the red blood corpuscles normal, some crenated, a great many white cells, and numerous micrococci and zoöglœa masses.

d. The urine taken from the urine bladder, when examined in the evening (September 10), contained a few blood corpuscles and some micrococci, but no zoöglœa.

e. The blood of the liver, examined September 11 at 11 o'clock a. m. The blood corpuscles the same as on September 10, the micrococci very numerous, and averaging three or four to one blood corpuscle. A few bacteria, apparently *Bacterium termo*, have made their appearance; on an average one is seen in every third field. Zoöglœa masses, the same as on the evening of September 10, and also a few long, straight, and very thin forms of schizophytæ, resembling or identical with *Bacillus subtilis*, as described and drawn by Cohn, and very much thinner than those found in the blood of the liver of Monahan's cow No. 1. The same, magnified about 925 diameters, appeared to be from the one-sixth to one-half an inch in length.

f. The blood of the vena cava, posterior of Mrs. Harris' cow, examined again September 14. (It had been kept in a new and clean vial, closed with a new and clean cork.) It contained numerous large *bacilli*, similar in appearance, but not quite so long as those found in the blood of the liver of Mr. Monahan's cow (see drawing No. I), but only a few micrococci. The blood had become slightly putrid, but did not smell very offensive. The *bacilli* showed less motion than those found in the liver of Monahan's cow, and I am not prepared to decide whether they were the same or not. No blood corpuscles could be found (see drawing No. VI). Examined once more the urine of Monahan's cow No. 2, and found the same full of *Bacteria termo*, single and moving, and in zoöglœa, while the urine of Mrs. Harris' cow, also examined again, contained rod-shaped forms resembling *Bacillus subtilis*, a few *Bacteria termo*, but no zoöglœa.

A final examination of samples of blood of Monahan's cow No. 2 and of Mrs. Harris' cow was made on September 15. The blood of the spleen of the former animal contained immense numbers of *Bacteria termo*, single and moving, and in zoöglœa, while only a few of the large *bacilli*, seen before, and only a few remnants of blood corpuscles could be found. Of the large *bacilli*, not more than an average of two in three fields could be seen; the blood corpuscles, it seems, must have become dissolved; the remnants yet existing presented a granulated appearance. The blood of Mrs. Harris' cow exhibited nearly the same features as at the last examination on the 14th, except that, besides the large *bacilli*, it contained quite a number of lively, trembling *Bacteria termo*, and had become more putrid.

4. *The blood of Mr. Ritschener's heifer.*—On October 3, when making the *post-mortem* examination of this animal, I took some blood from the posterior vena cava, some serum from the pericardium, pieces

TEXAS CATTLE FEVER.

Report Commissioner of Agriculture for 1880. Plate I.

Investigations by Dr. H. J. Detmers.

A. Hoen & Co. Lithocaustic, Baltimore

Spleen of Animal: affected with Texas Cattle Fever.

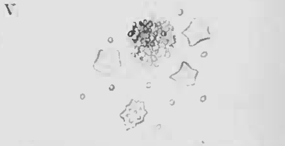
TEXAS CATTLE FEVER.

Microscopic Investigations by Dr. H. J. Detmers. Plate I.

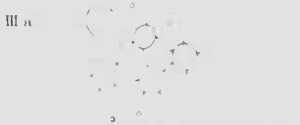
Bacteria in the liver of a cow that died of Texas Fever × 925 linear
Objective Tolle's 1/10 homog immersion
Eyepiece Beck's large "B" 4. 9. 80.

Blood from posterior vena cava of Mr Harris cow
1, 1, 1, Micrococci 0, 6 to 11 μ.-
2, 2, Blood cells, 3 fibrin - × 787.
Objective Hartnack's 1/16 im.
Eyepiece: Beck's A 7 P.M., 10, 9, 80.

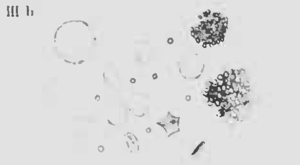
Bacteria and blood corpuscles as seen in the urine of a cow diseased with Texas Fever 12 hours after death × 925 linear
Objective Tolle's 1/10 homog immersion.
Eyepiece Beck's large "B" Time 3, 9, 80
•• Moving rapidly



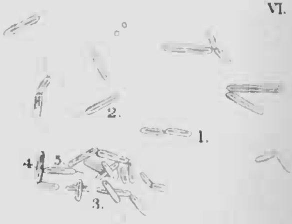
Blood from the liver of Mr. Harris' cow. × 925. Objective: Tolle's 1/10 hom. im
Eyepiece: Beck's B Micrococci.
Time: 8 P.M., 10, 9, 80.



Blood from the jugularis of Monohan's cow No 2 × 925 Objective: Tolle's 1/10 hom im Eyepiece Beck's "B" Time 9. 9. 80



Blood from the liver of Mr Monohan's cow No 2 × 787 Objective: Hartnack's 1/16 water im Eyepiece A 10 A.M., 10, 9, 80



Bacteria in the blood of Mr. Harris' cow, taken from the vena cava posterior.
1, Length 11 μ; thickness 1, 09 μ:
2, Length 8.5 μ; thickness 1 μ. × 925 linear.
Objective: Tolle's 1/10 homogeneous im.
Eyepiece: Beck's B Time: 14. 9. 80.
Flagella seen only on those in motion.
Most of the bacteria included above group 3 motion less, or moving slightly
4.- Length, 7 μ;
5.- Length, 7.2 μ. No blood corpuscles

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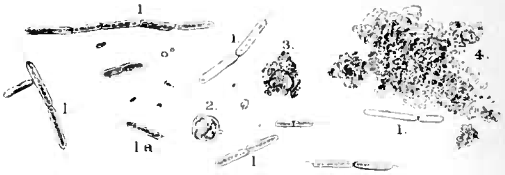
Report Commissioner of Agriculture for 1880.

TEXAS CATTLE FEVER.

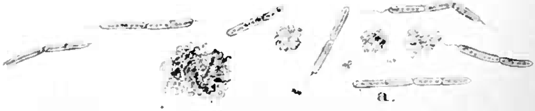
Microscopic Investigations by Dr. H. J. Detmers. Plate II.

VII.



A. – Blood from the vena cava posterior of Mr. Ritschener's cow, examined one hour after the post mortem examination at 10 A.M. 3. 10. 80. × 925. Objective, Tolle's 1/10 homogeneous immersion. Eyepiece, Beck's B.
1. 1. 1. Bacilli, 1a Bacillus with plainly visible flagella and moving.
2. Disintegrating blood corpuscle.
3. Disintegrated blood corpuscle.
4. Detritus.
Average length of bacillus-joints 8.25 μ, varying from 5 μ to 9.15 μ.

B. – Very long bacillus-chains imbedded in a mass of disintegrated or collapsing blood corpuscles of the blood or pulp of the spleen of Mr. Ritschener's cow.
Same time, amplification, objective and eyepiece as above.



C. – Blood from the liver of same cow: bacilli and collapsing blood corpuscles. Same time and amplification.
a. joint 11 μ long and apparently growing.

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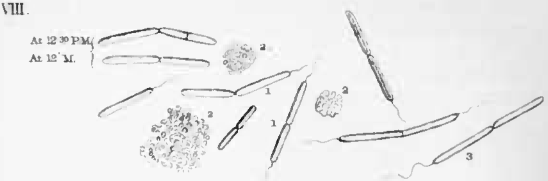
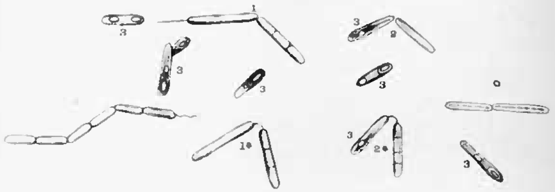
TEXAS CATTLE FEVER.

Microscopic Investigations by Dr. H. J. Detmers. Plate III.

VIII.

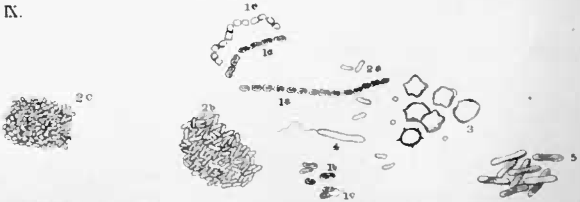


A. Blood of the liver of Ritschener's cow, at 12 M., same slide as examined at 11, A.M. Same amplification; Eyepiece and Objective. Most of the bacilli (1, 1,) measure each joint 11 μ, and have grown since first examination; 2,2,2, disintegrating blood and detritus. 3, A joint 13 μ long.



B. — Bacilli of the blood of the vena cava posterior of Ritschener's cow on a slide prepared at 10 A.M. as they appeared reexamined at 6 P.M. × 925. Objective: Tolle's 1/18 immersion and Beck's B. 1 and 1^a and 2 and 2^a the same bacilli, 1^a and 2^a 10 minutes later. 3, 3, 3, Helobacteria.

IX.



Blood of healthy beef, obtained in a butcher-shop, as it appeared about 54 hours after death. Examined at 8 P.M. 10, 10, 80. × 925. Objective: Tolle's 1/18 homogeneous immersion; Eyepiece: Beck's B. (No 2) 1^a Chain of Bacillus germs. 1^b Double Bacillus spores in process of division. 1^c The same 2 minutes later. 1^d Chain of double Bacillus spores in process of division. 1^e The same 2 minutes later. 2^a, Bacterium termo. 2^b Portion of Zoöglœa mass of Bacterium termo. 2^c, Portion of very dense Zoöglœa mass of Bacterium termo. 3, Blood corpuscles. 4, Bacillus with flagellum. Bacilli at rest.

A. Hoen & Co. Lithocaustic, Baltimore

of liver and of the kidneys, and some of the pulp of the spleen for microscopic examination. All these substances contained large *bacilli* evidently identical with those forms in the blood of the liver of Monahan's cow No. 1, and afforded me a chance to observe by continued and repeated examinations nearly the whole cycle of metamorphoses necessary to the development of the *bacilli*—multiplying by fission and propagating by lasting spores or helobacteria. All the various changes or forms are faithfully represented in the drawings No. VII, *a*, *b*, and *c*, and No. VIII *a* and *b*, and a detailed description may, therefore, be reserved till the true relation of those *bacilli* to the disease—if any relation is existing and their presence is not accidental—has been determined. I have yet to state that the micrococci found in the blood, &c., of the animals which died of Texas fever, are much larger than those found in swine-plague. I have made an attempt to ascertain whether those large *bacilli* are characteristic of Texas fever or whether their presence is accidental. As will be remembered they were found only once—soon after death—in blood from the liver of Mr. Monahan's cow No. 1, and in all other cases, not until the animal from which the blood was obtained had been dead 24 hours. To see, therefore, whether they would also appear in the blood of a healthy bullock, I procured some from a butcher and examined it under a microscope while it was yet fresh or without any perceptible smell, when it had become slightly putrid, and when it was thoroughly putrefied and decomposing. When first examined the animal from which it was obtained had been dead about 30 hours, and nothing abnormal was found except in a few fields one or two *Bacterium termo* were seen. At the second examination 24 hours later—the blood was kept in a warm room—it contained immense numbers of *Bacteria termo*, single and in dense zöoglœa, and quite a number of *bacilli* identical in appearance to those found in the blood of Mrs. Harris' cow when examined on September 14, and represented in drawing No. VI, but probably different from, or at any rate smaller (shorter and thinner), than those found in the blood of Monahan's cow No. 1 (drawing No. I) and in the blood of Ritschener's heifer (drawings No. VII, *a*, *b*, *c*, and VIII, *a* and *b*). Whether the same, notwithstanding, are all identical or not I am not yet prepared to decide, and if they are it is not impossible in spite of all the precautions taken that the blood of the healthy bullock may have become invaded by bacillus spores in my room, when the vial was opened for a moment to obtain some of its contents for the first examination 24 hours before the *bacilli* were found.

Some of the solid tissues morbidly affected, such as the liver, spleen, kidneys, &c., have also been subjected to microscopic examination, but as I expect to get good microphotographs from the slides prepared, I will not now give a detailed description.

Respectfully submitted.

H. J. DETMERS.

CHICAGO, ILL., *December* 20, 1880.

BRONCHITIS IN CATTLE..

Prof. W. Williams, of the New Veterinary College of Edinburgh, Scotland, has, during the past few years, paid much attention to the study of diseases affecting the air-passages and lungs of domesticated animals. In the second edition of his work, which seems to have been revised with great care, he treats at considerable length of the diseases known as pleuro-pneumonia contagiosa and bronchitis in horned cattle, and points out with distinctness the difference between those diseases. His conclusions are of great importance in the present controversy. In the preface to the second edition of his work, Professor Williams says:

The existence and characteristics of pleuro-pneumonia contagiosa and bronchitis in horned cattle were lately the subject of differences of opinion between the veterinary officers of the privy council and the author, in connection with the alleged existence of pleuro among American cattle imported into this country, and slaughtered at Liverpool to prevent contagion. The author has very carefully studied the *post-mortem* appearances of both diseases, and submits his conclusions to the profession. The opportunity of studying the *post-mortem* appearances of bronchitis in its earlier stages but seldom occurs; and had it not been for the slaughter of the cattle referred to, the lesions induced by the initial stages of inflammation of the bronchial tubes could not have been so minutely demonstrated.

The author does not deny the existence of pleuro in some of the Eastern States of America, but it has not yet been proved that this contagious malady prevails in the Western States, from whence cattle are brought to this country. Of this, however, he is confident, that in none of the diseased lungs of the cattle referred to did he find the characteristics of contagious pleuro; but, in all, those of bronchitis. In this investigation he has received much valuable assistance from Dr. Hamilton, pathologist to the Royal Infirmary, and demonstrator of morbid anatomy in the University of Edinburgh.

The following is the full text of Professor Williams's paper on the disease of bronchitis in cattle. It appeared in the appendix to a recent report of Dr. Lyman, and may also be found in Special Report No. 34 of this department. It is inserted here as confirmatory of the position taken by Dr. Lyman after a thorough and searching investigation of the whole matter, viz., that American cattle landed in Great Britain prior to his late visit and during his stay in that country, although condemned and slaughtered under the regulations prescribed for the condemnation and slaughter of animals affected with contagious pleuro-pneumonia, were not afflicted with that disease. Professor Williams says:

DIVISION.

This disease may, according to its seat, be arranged under four heads, namely, "tracheo-bronchitis," where the lower part of the trachea and larger tubes are the main seat of the inflammation; "bronchitis proper," where the medium-sized bronchi are the chief seats of the disease; "capillary bronchitis," where the smaller bronchi are chiefly implicated; and "catarrhal, lobular, or broncho pneumonia," where the smallest bronchi and alveolar walls are involved in the inflammatory process. For simplicity of description I shall retain the generic term bronchitis, dividing it into acute and chronic.

The character of the inflammation, whatever part of the respiratory tract may be affected, is what is understood as catarrhal—that is, an inflammation in which, instead of an exudation rich in fibrin, there is a fluid secretion containing a large quantity of

mucus and cellular elements. In this particular it differs most essentially from inflammation of the lungs, originating in the parenchyma, and from pleuro-pneumonia, in which the pleural surface, as well as the lung structure, is involved. The exudate in these is termed "croupous" or fibrinous.

CAUSES.

Bronchitis, wherever its seat, is generally due to exposure to cold; it may supervene on an attack of ordinary catarrh, particularly if the animal be neglected, exposed to wet and cold, or kept in ill-ventilated stables. It may also arise without any premonitory catarrhal symptoms in both horses and cattle during voyages by sea, particularly if the weather be rough and stormy, and the animals battened down. During 1877 the author had the opportunity of seeing bronchitis in its purest form, and which proved fatal to many amongst foreign horses imported at Leith. An instructive fact in connection with these cases was that it appeared only after rough and stormy passages; when the weather was fine no cases were observed.

Among cattle shipped to this country from America during the earlier and spring months of 1879, bronchitis was observed almost identical with that seen among the foreign horses already alluded to; as the season advanced, and the weather became warm and less stormy, the disease disappeared.

Bronchitis, like laryngitis, may be caused by the inhalation of irritant matters, and by the accidental entrance of foreign materials, as medicines or food, into the bronchial tubes. Inflammation of the bronchial tubes arising from the latter cause usually occurs in horned cattle, often as a sequel to parturient apoplexy, in which affection the power of deglutition is in a great measure lost, and where the sensibility of the glottis is, during the comatose stage, greatly diminished or entirely absent. In such cases fluid medicines incautiously administered enter the trachea and bronchi, and these may cause immediate death by suffocation, or, if not immediately fatal, induce a severe and perhaps fatal inflammation.

Again, during the state of coma, semi-fluid ingesta are apt to flow into the mouth through the flaccid œsophagus, particularly if the cow lies with its head and anterior extremities lower than the posterior ones. In parturient fever there is also very often during the earlier stages some extent of antiperistaltic action of the œsophagus, with eructations of gases from the rumen; along with such gases semi-fluid ingesta gain entrance into the fauces, and, owing to the paralyzed state of the glottis, fall into the larynx and trachea.

Catarrh or bronchitis, from other than mechanical causes, may, particularly in cattle, if the accompanying cough be long and powerful, cause some degree of vomition. The food thus vomited, or in other words, coughed up, sometimes gains entrance into the trachea and causes a fatal issue.

Along with Mr. Borthwick (Kirkiston), I saw cases of this kind in a herd of Irish cattle brought to Scotland, and which were suffering from bronchitis and gastric irritation from neglect and exposure. Four of the herd became much worse than the rest; one died, and the other three were slaughtered. In all of them the bronchial tubes were filled with ingesta, ejected into the fauces during violent fits of coughing. Again, in several specimens of the lungs of American cattle slaughtered at Liverpool, supposed to be affected with pleuro-pneumonia, food was found in the bronchi. Is it not possible that during a rough voyage cattle may suffer to some extent from sea-sickness, and even vomition, and that the vomited matters may gain access into the trachea and bronchi? In others of the condemned American cattle the irritation was associated with the presence of filaria in the bronchi. Both the ingesta and the parasites were present only in a minority of the diseased lungs examined, and could therefore be only looked upon as accidental concomitants.

Food sometimes gains access into the trachea in the course of dissolution, or even after death, particularly if the rumen be rather full of moist food; it will then be found in the greatest abundance in the trachea and larger bronchi, whereas in those instances in which it has been in the tube for some time before death the food will often have disappeared from the larger into the smaller tubes and air cells.

I have witnessed one case of fatal bronchitis in the horse, due to the entrance of vomited ingesta into the bronchi. Some days prior to its death fifteen minims of Fleming's tincture of aconite had been administered; this brought on attempts at vomition and great distress. The animal's respiration continued very highly accelerated after the effects of the aconite had passed off, and continued until the animal died. A *post-mortem* examination revealed the fact that vomition had occurred, and that the small quantity of food thus expelled had entered the larynx and gained access to the bronchi.

ACUTE BRONCHITIS.

Symptoms.—Bronchitis consists of congestion of the bronchial tissues, associated at first with dryness, narrowing, and rigidity, and subsequently moisture, dilatation, and relaxation of the tubes.

Owing to these changes, the vibrating sounds caused by the passage of air through

the inflamed bronchi undergo variations, which indicate pretty clearly the dry or moist condition of the parts, or, as some term it, the dry or moist catarrh.

As the symptoms are developed, the cough becomes hoarse, ringing loud, and paroxysmal; the respirations are in some instances greatly accelerated, indeed out of all proportion to the pulse. For example, the pulse may be seventy or eighty per minute, and the respirations as numerous, or even more so. This indicates bronchitis affecting the smaller tubes and alveolar walls—catarrhal pneumonia—collapse of a more or less extensive area of lung structure, or even occlusion of non-inflamed bronchi and air vesicles by the gravitation into them of the catarrhal fluid, as shown in the illustration.

Bronchitis of the larger tubes is naturally less dangerous than the other two, and only proves fatal by inducing the two above-mentioned conditions, namely, collapse and occlusion of a more or less extensive breathing surface.

Amongst the foreign horses above alluded to, it was noticed, where the discharge of muco-purulent matter was most profuse, although some of the animals seemed to recover from the febrile disturbance and accelerated breathing of the acute stage, that they succumbed in from fourteen to thirty days afterwards from gangrene of the collapsed lungs, or putrefaction of the fluid incarcerated in the bronchi and air cells; both of these conditions being expressed by a fœtor of the breath, exhaustive diarrhœas, metastatic inflammations of the articulations and feet, complete loss of appetite, rapid emaciation, fluttering pulse; at first great elevation of temperature—106° F. or more; partial sweats upon the body, gasping respiration, some abdominal pain, and other signs of general septicæmia.

In no case of pure bronchitis is the breathing painful, but short and quick, the thoracic as well as the abdominal muscles being brought into full play; this distinguishes it from the breathing characteristic of pleurisy, in which the ribs are more or less fixed and the respirations abdominal. In ordinary cases of bronchitis the animal is dull, listless, sometimes semi-comatose; hangs its head; is generally thirsty; ropy saliva fills the mouth, which is hot and moist. The visible mucous membranes are infected and present a varying degree of lividity, due to non-oxidation of the blood. The animal stands in a corner or moves listlessly about. If in a box, and the door be open, it stands with its head to the open air, from which it evidently obtains relief. The bowels are generally somewhat constipated, the feces covered with mucus, but they easily respond to purgatives showing that the alimentary mucous membrane participates in the irritation. The urine is high-colored, scanty, and if examined will be found to contain urea, mucus, and coloring matter in excess, and the chlorides in diminished quantities.

As already stated bronchitis of the larger tubes is not ordinarily a fatal disease, but when affecting the smaller bronchi and alveoli, particularly if associated with a profuse discharge of yellowish-colored, more or less tenacious fluid, which occludes the smaller bronchi and air cells, it is the most fatal chest disease that the author is acquainted with. This tendency to gravitation of the catarrhal fluid is explained by the fact that the columnar and ciliated epithelium are shed in the earlier stage of the attack and take no part whatever in the after changes which ensue. It is never seen again till the signs of acute inflammation, such as distension of the vessels and œdema of the basement membrane have passed off. Subsequently it is gradually reproduced.—*Dr. Hamilton.*

The muco-purulent material thus incarcerated is driven or impacted by the ramrod-like action of the inspirated air into the periphery of the smaller tubes and vesicles, and there constitutes those masses which may undergo putrefaction in the horse, causing septicæmia, as already explained, and caseous masses, giving rise to tubercle in the ox.

The physical signs of bronchitis are as follows: Percussion returns a more or less resonant sound, but auscultation will enable the practitioner to detect the nature and extent of the bronchial inflammation. *Rhonchus*, confined to the upper and middle third of the chest, with true respiratory murmur over the lower part, will indicate inflammation of the larger and middle-sized bronchial tubes and a condition of comparatively little danger. *Sibilus*, heard at the lower parts, indicates a condition of much greater danger and that the disease involves the smaller tubes and air vesicles. Inspiration is generally shortened, expiration prolonged and more distinctly accompanied by the abnormal sounds. These sounds are succeeded at a later stage by moist bubbles, rattles, or rales—mucus rales. At first the discharge expelled by coughing is thick, tenacious, and gelatinous, or watery and scant. The lower animals do not, however, expectorate in the true sense of the word; some discharge issues from the nose, but the greater part of what is coughed up falls into the fauces and is swallowed. As the disease advances, however, a profuse discharge issues from the nostrils and the inflammation gradually subsides. The cough becomes less hoarse, more vigorous, and even more frequent than at first, but it gradually disappears; the discharge becomes again thinner, clearer, and eventually ceases.

In some instances all sounds disappear from a certain part of the lungs. This is due

to occlusion of the tubes and vesicles by the catarrhal secretion, or to more or less collapse of the vesicular tissue, dependent on obstruction to the passage of air during inspiration by glutinous or inspissated mucus. This collapse is often confined to individual lobules, which are thus condensed, heavy, indurated, and of a dark color, and may ultimately become hepatized, atrophied, or even emphysematous.

PATHOLOGY AND MORBID ANATOMY.

Inflammation of the bronchial tubes, like that affecting other mucous membranes, is attended with changes in their epithelium, the secretion of the glands, and in the surrounding tissues.

It is rare to meet with a fatal case of bronchitis during its earlier stages, and but for the accidental slaughter in Liverpool of the American cattle already referred to, it would have been difficult to have given the details of the morbid anatomy.

The appearance of the lung in the earlier stage of bronchitis, with collapse, that is to say, when it is observed prior to the commencement of secondary changes or pneumonia, is as follows: There are patches over its surface that have fallen below the level of surrounding parts; sometimes these depressions measure an eighth of an inch in depth; they are of a bluish purple color, and variable in size. The parts around them are of a light pink hue, and are either healthy or in a more or less emphysematous condition.

The depressions consist of certain lobules in a state of collapse arising from occlusion of their bronchial tubes by pus or other material. The collapsed portions are bluish-purple in color; non-crepitant and depressed, resembling fetal lungs, sinking slowly in water.

Collapse of the lung tissue, atelectasis, induces more or less congestion and subsequent inflammation; consequently it is found that broncho-pneumonia often succeeds bronchitis, due to the absence of the expansion and contraction of the air vesicles which normally aid the pulmonary circulation, and to arrestment of the blood-flow, owing to imperfect aeration. This congestion is soon succeeded by effusion of serum, and the bluish-purple collapsed portions become darker in color and less resistant in consistence. They, however, retain some degree of elasticity, for, if not too rudely pulled out, they do not tear as in pleuro-pneumonia; if cut into and exposed to the atmosphere for a few minutes the bluish-purple color becomes bright scarlet. It is important to bear in mind that the pneumonic process which supervenes in bronchitis is principally confined to those portions of the lungs in which collapse has taken place. Sometimes the collapse is isolated, invading but small portions of the lungs. This condition is not rarely witnessed in parasitic bronchial disease. These limited collapsed portions vary in size, are rather wedge-shaped, and have their apices towards the obstructed bronchos. The lung tissue surrounding them may be more or less congested, or it may be emphysematous, but no juice is exuded from them when cut into as in acute pleuro-pneumonia.

Professor Gairdner was, I believe, the first to show that condensation of the vesicular substance occurs as a result of mucus or other obstruction in the air-tubes leading to the condensed portion. It is at first sight difficult to understand how incomplete obstructions of the bronchi—and these obtain much more frequently than absolutely complete occlusion—cause collapse. One would suppose that some quantity of air would gain access into the vesicles, but such is apparently not the case; and it seems that the air gradually finds its way out by the edges of the obstructing substance. The expiratory force, so long as there is air in the vesicles, constantly tends to dislodge the obstructing body by pushing it toward the wider (proximal) end of the tube, whilst the inspiratory drives it inwards toward the narrower tubes, which it effectually occludes. The entrance of air is thus more or less effectually opposed and its exit permitted, so that ultimately the vesicles beyond become completely emptied; in fact, the plug acts as a valve, allowing the air to pass in one direction but opposing its passage in the other. Where the obstruction is complete from the commencement the air is absorbed.

It had been supposed by Laennec that the emphysema or, more correctly, over-distension with air of the parts surrounding the collapsed lobules, was due to what he thought a fact, that the act of inspiration was more powerful than that of expiration; so that though air could be drawn through the obstruction it could not be breathed out. In consequence, it accumulated in the ultimate pulmonary vesicles, became expanded by heat, and so acted mechanically as a dilator. Dr. Gairdner, however, pointed out that expiration is a much more powerful act than inspiration, and that there is never any difficulty in causing expulsion of air, provided always there be no obstruction in the tubes. Emphysema, then, does not occur in the vesicles connected with obstructed tubes, but in those which are adjacent. When the lungs are free from disease the column of air presses equally in all the tubes and vesicles; but when one portion connected with any obstruction is collapsed, then the adjacent parts are over-expanded, so as to occupy the space previously filled by the former.

At a later stage the contents of the obstructed bronchi are pushed by the weight of

the descending or inspired atmosphere into the most minute bronchi, alveoli, and air vesicles, always from the center towards the periphery, and appear as minute white points beneath the pleural surface. They are well shown in the figure.

On cutting into the lungs, it will be found that the large and small tubes, and sometimes the trachea, contain an amount of fluid. This condition, as well as the collapse, is limited in the majority of instances to the small or anterior lobes of the lungs, and rarely, except by extension, affects the large lobes, not only in ordinary but in mechanical bronchitis. This fact is of importance, as pleuro-pneumonia contagiosa, with which the disease under consideration has been confounded, generally commences in the larger lobes, either in their centers or towards their posterior edges.

The fluid contained in the tubes is thick and has a yellow color; in the trachea it is more or less frothy; and is abundant in the smaller bronchi, as shown in the figure.

If the lungs in this condition be squeezed, little pellets of yellow matter are pressed out. Sometimes these pellets are too small to be seen by the naked eye, and require the aid of a magnifying glass. If the bronchitis be associated with catarrhal pneumonia, elevated patches will be apparent on the cut surface, having a grayish red color. They are soft to the touch, and if squeezed the same muco-purulent matter exudes from them, or from a small bronchus which may happen to communicate with the particular group of vesicles implicated.

Dr. Hamilton, in his series of papers on bronchitis, published in the *Practitioner* for 1879, states it is a matter of difficulty in man to get at the first change which ensues in the bronchi in acute catarrh. He has, however, been able to verify his observations by an examination along with myself of the lungs of American cattle slaughtered in the earlier stages of bronchitis; in fact before any external signs of disease were manifested. He says, "On careful comparison, however, of many cases, we feel assured that the first deviation visible is a *relaxation and distension of the abundant plexus of blood-vessels ramifying in the inner fibrous coat*, immediately beneath the basement membrane—that is to say, of the branches of the bronchial artery. They become engorged with blood, so that on transverse section they appear like little cavities distended with blood corpuscles. In a few hours afterwards the basement membrane* becomes much more apparent than it usually is, and at the same time more clear and homogeneous, while the surface is thrown into many folds. These changes in the basement membrane are apparently due to its becoming œdematous, serous fluid being infiltrated into it from the underlying plexus of distended vessels; and we shall see that, as the acute irritation continues, this œdematous state of the basement membrane becomes more and more a well-marked feature. The next change, so far as we have been able to calculate, occurs in from twenty to thirty hours after the primary distension of the vessels, and consists in the loosening and desquamation of the columnar epithelium at the foci of greatest congestion.

"The columnar epithelium is thus shed at a very early stage of the attack, and takes no part whatever in the after changes which ensue. It is never seen again until the other signs of acute inflammation, such as the distension of the vessels and œdema of the basement membrane have passed off. Subsequently we shall see that it is gradually reproduced. The cause of this desquamation of the columnar epithelium seems to be the œdema of the basement membrane loosening its underlying attachments, very much in the same way as the vesicles which form in an acute inflammatory affection of the skin loosen the attachments of the superficial layer of epidermis. The removal of this protective covering from the mucous membrane naturally leaves the latter in an exposed condition, and no doubt the feeling of rawness experienced in acute catarrh of the bronchi is due to the cold air acting upon an over-stimulated and exposed mucous membrane. And, further, it can easily be understood that, where this desquamation takes place to an inordinately great extent, the loss of the ciliary action of the columnar cells will seriously interfere with expectoration, and tend to cause the catarrhal products to gravitate downward towards the smaller bronchi and air vesicles. This description essentially coincides with what Socoloff found experimentally in animals (Virchow's *Archiv.*, vol. 68, p. 611), in which he induced an artificial bronchitis by the injection of irritants, such as potassic bichromate, into the air-passages. He states that one of the first changes which ensued was the desquamation of the columnar cells, and that they took no part in the catarrhal inflammatory process."

This early shedding of the columnar cells, and their non-reproduction until after the subsidence of the inflammatory process, is a fact of real importance, as it goes a long way to explain the occurrence of those caseous tumors which give rise to tubercle, and are so often confounded with that growth.

The pneumonic process, which may supervene either by extension of the inflammatory process from the tubes to the alveoli or the irritation of inhaled inflammatory products subsequent to collapse, is, in the earlier stage, commonly limited to scattered groups of air-vesicles; hence the term "lobular" which is applied to it. It causes the portions affected to appear as scattered, ill-defined nodules of consolidation, irregular

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* The basement membrane is not so apparent in the lower animals as in man.

in size, and passing insensibly into the surrounding tissue, which is variously altered by collapse, emphysema, and congestion. These nodules are of a reddish gray color, faintly granular or smooth, slightly elevated, and soft in consistence. As they increase in size they may become confluent; and in a more advanced stage they become paler, drier, firmer, and, to some extent, resemble ordinary gray hepatization. Microscopically examined, they are seen to consist of cellular elements accumulated in the alveoli.

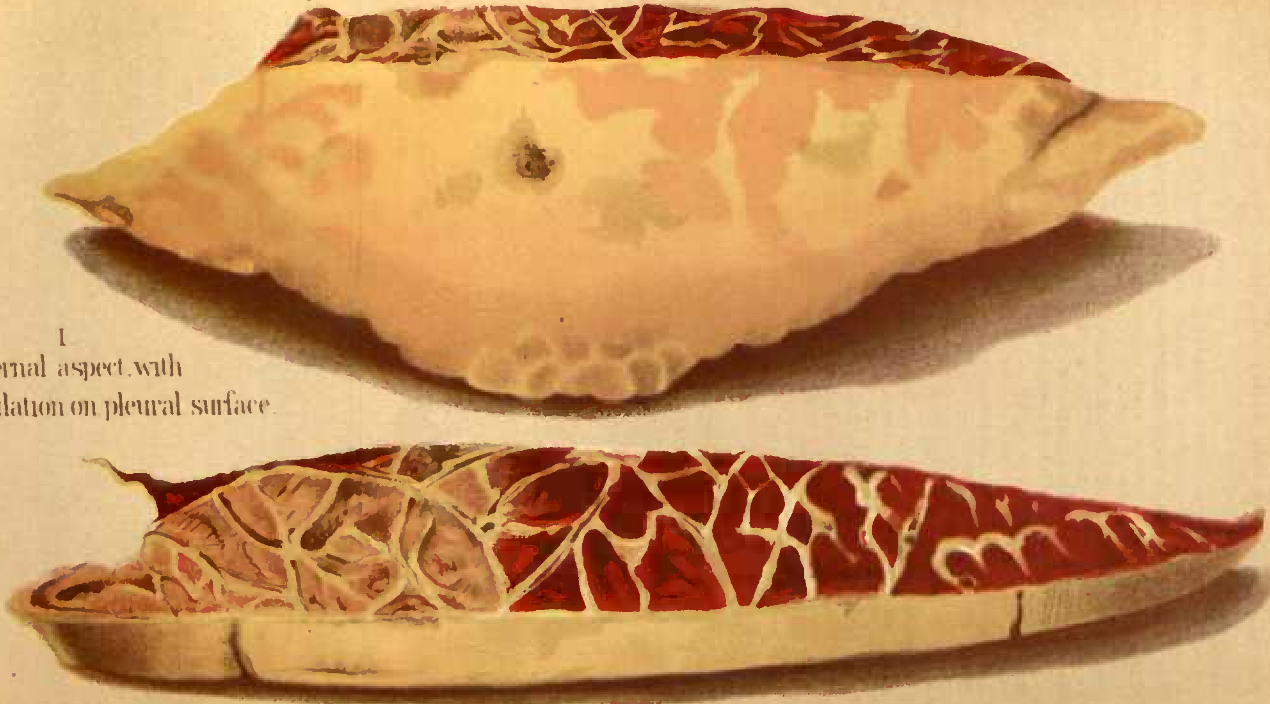
The disease may, as already remarked, terminate fatally by the absorption of the putrescent catarrhal products, by gangrene of the collapsed lungs, or by sudden effusion of fluid into the bronchi, constituting what is termed "suffocative catarrh." If a fatal termination does not ensue the contents of the alveoli undergo degeneration and are gradually removed by discharge, or by absorption, or by coalescence from caseous masses, which may become encapsuled, undergo the calcareous change, and thus become innocuous; or may induce a diathesis, leading to the actual development of tubercle in the ox and to symptoms simulating phthisis pulmonalis in the horse; that is to say, an accumulation of catarrhal products, epithelial and other cells within the pulmonary alveoli, cellular infiltration and thickening of the walls of the alveoli and bronchi, increase in the interlobular connective tissue, with, in some instances, the occurrence of fibrinous masses intermixed with leucocytes in the alveoli, as demonstrated by Zenker, of Dresden, but without—except very rarely, indeed, in the horse—the occurrence of tubercular tumors (grapes) in the serous membranes and parenchyma of organs.

In all cases of bronchitis the bronchial glands undergo some change. In the earlier stages they are increased in size, contain the products of the bronchitis conveyed by the lymph tract, become more or less friable in consistence, and in more advanced bronchial inflammation distended with catarrhal elements, both glands and contents undergoing the caseous metamorphosis, the products of which may either liquefy or become infiltrated with calcareous matter.

Drawings showing comparative appearances of PLEURO-PNEUMONIA CONTAGIOSA AND BRONCHITIS.

A. PLEURO-PNEUMONIA.

After Prof. W. Williams.



I

External aspect, with exudation on pleural surface.

II. Internal aspect of same lung showing marbled condition.

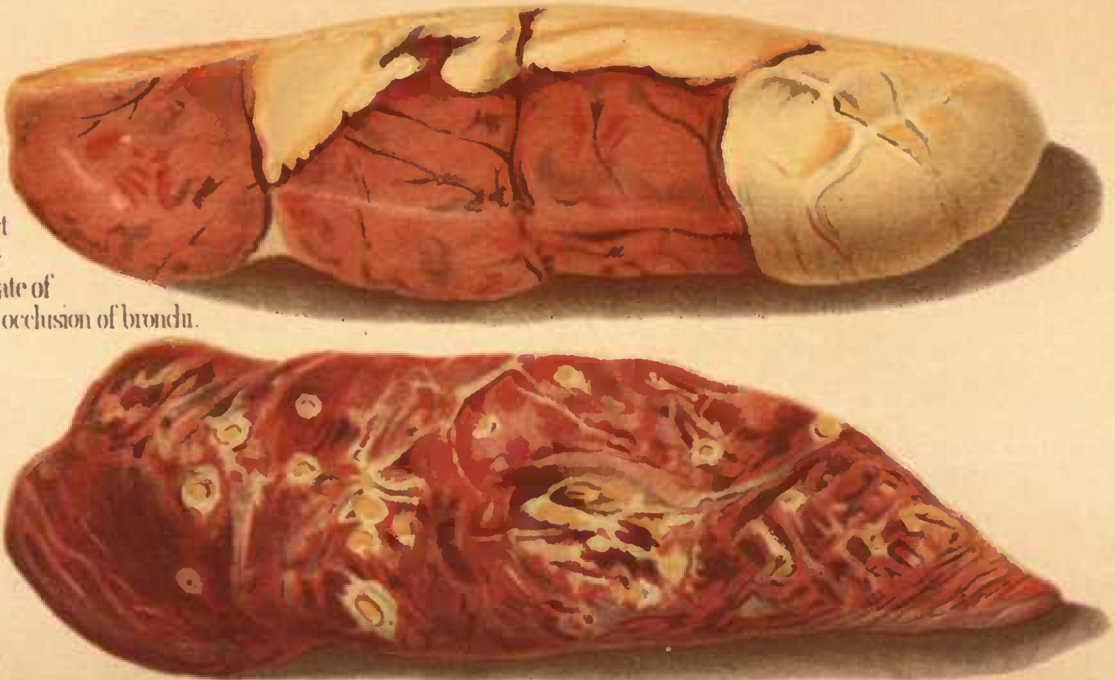
Report Commissioner of Agriculture for 1880

Plate I.

A. Hoen & Co. Lithocaustic Baltimore

B. BRONCHITIS. (Earliest Stage).

After Prof. W. Williams.



External aspect some of the lobules in a state of collapse from occlusion of bronchi.

II. Internal aspect of same, bronchi filled with catarrhal products.

A. Hoen & Co. Lithocaustic Baltimore

Contagious Pleuro-Pneumonia of Cattle.

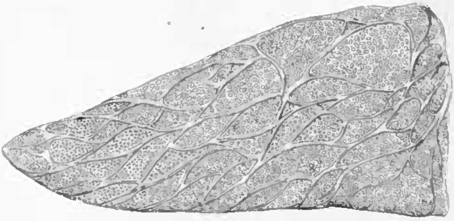


Fig. 3.–*Pleural aspect of pulmonary lobe from American ox slaughtered at Liverpool; alveoli filled with muco-purulent matter; pleural surface intact. The microscopic examination revealed broncho-pneumonia in some of the alveoli (see fig 6); whilst others showed no traces of inflammation (see fig. 1), but were merely filled with the inhaled bronchial secretions.*

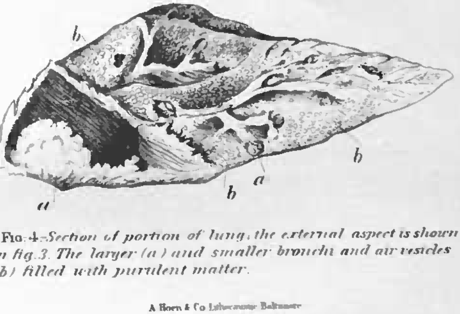


Fig. 4.–*Section of portion of lung; the external aspect is shown in fig. 3. The larger (a) and smaller bronchi and air vesicles (b) filled with purulent matter.*

A. Hoen & Co. Lithocaustic Baltimore

Contagious Pleuro-Pneumonia of Cattle.

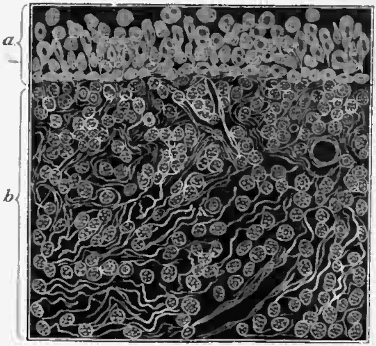


Fig. 5. *Bronchus (medium sized) in acute bronchitis.—(American ox slaughtered at Liverpool.)*
(a) Deep layer of epithelium, germinating and throwing off catarrhal cells.
(b) Inner fibrous coat, infiltrated with inflammatory cells. (480 diam.) The columnar epithelium shed.

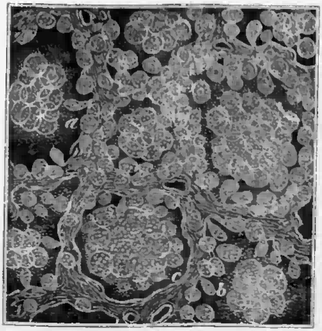


Fig. 6.—*Acute catarrhal pneumonia (American ox).—Section through several air vesicles. Shows the alveolar cavities filled with large granular catarrhal cells (c). (b) Catarrhal cells sprouting from the alveolar wall. (a) Coagulated mucus in which the catarrhal cells lie.—(480 diam.)*

A. Hoen & Co. Lithocaustic, Baltimore.

CONTAGIOUS PLEURO-PNEUMONIA OF CATTLE.

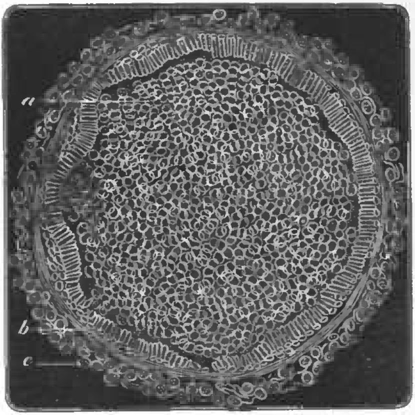


FIG. 1—*Small bronchus in acute bronchitis, occluded by a plug of catarrhal secretion—350 diam. a, Catarrhal plug. b, Epithelium lining bronchus. c, Surrounding adventitious coat infiltrated with cells.—(From American ox condemned at Liverpool for pleuro pneumonia.)*

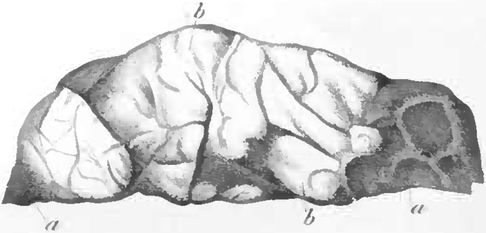


FIG. 2.—*Portion of lung from American ox slaughtered at Liverpool, and showing bronchitis in the very earliest stages (a a, collapsed lobules) from obstruction of tubes. The elevations (b b, non collapsed lobules) are slightly emphysematous.*

A. Hoen & Co. Lithocaustic, Baltimore

DEPARTMENT CORRESPONDENCE.

The correspondence of the department is one of the most distinguishing features of its operations, embracing as it does the current information of the progress of agriculture at home and abroad, an interchange of seeds, &c., with foreign governments and individuals, and inquiries as to such new and valuable seeds as the department may have for distribution and trial, and particularly as to the most approved methods of culture. The department, while it has availed itself of such opportunities of obtaining information as this correspondence has afforded, has freely, and as fully as was practicable, responded to the various inquiries. This correspondence has been held, not only with the regular and numerous corps of reporters, and with agricultural societies, and with individuals in every section of the country, who make occasional calls for information and advice, but with foreign governments, United States consuls, and other persons in foreign countries who are accustomed to solicit information from the department in relation to agriculture and kindred topics, as the result of experience in this country. We subjoin a few notes from this correspondence, which are of general interest.

CINCHONA.

The department has received from the United States consul-general at La Paz, Bolivia, a package of quina seed (*Cinchona calisaya*), kindly designed by him, as he remarks, "for the purpose of having experiments made, whether this valuable plant may not be cultivated in the southern portion of the United States." Thanking the consul-general for his attention in the matter, we have taken occasion, for his information, to state that many years ago public attention was called to the desirability of introducing the cultivation of cinchona into this country, and that this department, during the last fifteen years, has distributed young plants of several species of the plant in those sections of the country where there was reason to believe the conditions requisite to its growth existed. The result thus far has been unsuccessful, but not such as to be regarded as conclusive, or to authorize a discontinuance of efforts to secure, if possible, the end so much to be desired. The efforts hitherto made have necessarily been partial and limited. The department has been without the means of inaugurating such a system of thorough and carefully conducted experiments as is indispensable to a satisfactory determination of the question as to the capabilities of any point within our national limits for the culture of cinchona. The department has repeatedly called the attention of Congress to the subject, and urged upon it the duty of providing means for enlarged and more decisive experiments. Without being discouraged by its want of success hitherto, the distribution of plants, now in course of propagation, will be continued by the department, with a view to further experiments, as far as circumstances will justify. We subjoin an extract

from the consul-general's communication, containing directions for cinchona culture as practiced in Bolivia:

The seed is sown broadcast upon a hot-bed such as gardeners prepare in the spring for their early vegetables. The manure of the llama, for which in the United States sheep-manure might be substituted, is freely mixed with the surface soil of the hot-bed; and, as the seed is very light, it should be slightly raked under and the surface kept moist. As soon as the sprouts appear, a shade should be constructed over the bed, covered simply with leaves, straw, or branches of trees, which, while it protects the tender plants from the hot sun, may allow the rain to penetrate and fall gently upon them. It is advisable to locate such hot-bed on a hillside, so that the water may quickly run off, continuous and limited moisture being required, rather than quantities of water and heavy rainfalls.

As soon as the plant has grown to a height of from 6 to 8 inches, it is ready for transplanting. The ground chosen for a quina plantation should also be sloping, if possible, on the south side of hill or mountain, as experience has shown here that those located on level land do not prosper, and steep mountain sides are here preferred. The plants are set at regular intervals, 8 feet apart and it is only necessary, if not better, to prepare the soil within a foot of where each plant is placed, as I am assured that by plowing the whole field too much moisture would be retained in the soil. The plants are then slightly covered with fallen leaves or other rubbish to protect them from the hot sun a while longer, until they show a strong and healthy growth, after which all further care seems to be unnecessary, in Bolivia, at least, where even the weeds are but superficially removed.

A damp, warm climate, with heavy dews at night and cloudy sky during the day, rather than a hot, burning sun, such as may be found in the mountainous regions of some of the Southern States, like Alabama and Georgia, where mists and threatening clouds hang over the mountains in summer, and still no severe frosts occur in winter—this seems to be what is required for the cultivation of this plant; and I should not be surprised if the experiment should, under such conditions, prove successful, a result which would undoubtedly add greatly to the wealth and prosperity of the South.

Bolivia being in the southern hemisphere, the seasons for sowing and transplanting in the United States will have to be changed; the former, instead of in October, here should be done in April, and the latter in July instead of January here.

From these intervals it will be seen that the seeds require a long period to germinate and obtain their first growth; but from all accounts, if the above directions are followed, and a little patience shown in the beginning, very little, if any, cultivation and trouble is necessary after the plant is transplanted and becomes firmly rooted and shows a healthy growth.

In from five to six years the tree grows to a height of about 10 feet and 5 to 6 inches in diameter, and at that age the bark contains the greatest percentage of quinine, and is worth in Bolivia from $180 to $200 per quintal of 100 pounds. When the tree has attained this size and age, it is cut down close to the roots, the bark stripped entirely from the trunk and branches, and one of the new shoots from the root is allowed to grow into a new tree. In India, I am told, the custom prevails to strip only half the tree, and allow this to grow again before the other half is taken off; but by this process, I am assured, the percentage of the sulphate contained in the second growth is much smaller than that gained by the method practiced here.

CULTURE OF GINSENG IN JAPAN.

Ginseng, as is well known, is not cultivated in this country at all, our supply being dependent entirely upon the spontaneous growth of the plant, which is abundant in many portions of the country. It is said, however, that it is becoming scarce, and as it is of very considerable commercial value, the department is frequently inquired of as to the practicability of its successful and profitable cultivation here. It was formerly supposed to possess valuable medicinal qualities, but its importance in that respect is not now recognized. Its value in this country, therefore, is wholly commercial. It is gathered exclusively for exportation to China, where from time immemorial it has been, and still is, in great demand, being regarded as an important drug, and entering into the preparation of almost every medicine. The exports amount to about half a million pounds annually, of the value of about $700,000. We have received from a correspondent in Gotha, Germany, an account of

recent travels in Japan, including a minute and interesting description of ginseng and its culture in that country, where it is grown largely for exportation to China, which seems to enjoy the monopoly of its consumption. We have translated this description, and here reproduce it for the benefit of those who are interested in the question of cultivation, and may contemplate experiments in that direction:

The "ginseng plant" (*Panax*, Jap. "*Ninjin*"), of bushy growth, belonging to the family Araliaceæ, presents in its cylindrical dark roots a medicine highly prized by the Chinese and Japanese. In fact, the ginseng is to those people what quinine and musk are to us in fevers and general debility, the most expensive as well as most relied upon remedy.

Symbolic of the price of this medicine is the Japanese saying, "Ninjin kute kubi kukuru," literally translated, "Death follows upon eating ginseng." But a more sensible translation is as follows: "Ginseng only cures us to let us die from starvation" (as it empties our purse).

The ginseng plant grows wild in the shady mountain forests in Eastern Asia, from Nepal as far as Manchooria, while in Japan it was found until lately only cultivated.

In the large forests of Chinese Manchooria, between 39° and 47° north latitude, the first plants were noticed by Father Jartoux; but although these roots were carefully gathered, the amount was far too small for the demand of China; and thus its cultivation was started in Northern China, Corea and Japan taking part in the enterprise, and still, to supply the steadily growing demand, it was for several years imported from Baltimore and Philadelphia, which places gathered the *Panax quinquefolium* growing in the Alleghany Mountains.

The Japanese select for the culture of the ginseng tree black, humous, and not too wet soil as the only kind in which it will attain perfection and become pure white, as if grown in ferruginous soil it becomes reddish, and is less valuable.

The well-prepared, and if necessary, well-manured soil is laid out in beds, always east and west, about 27 Japanese feet long, 2½ feet broad, and a distance of 2 feet between each. To protect the plants from the direct rays of the sun and from heavy rain-storms each bed is protected by a roof made of straw and laid upon poles supported on posts.

In Southern Japan, in the provinces of Idzumo and Hoki, the planting takes place in November, and farther north in April.

In the deeply-dug and well-prepared bed the seed is deposited 2 to 3 inches apart every way, so that there will be a distance of about 1 foot (Japanese) between each. It is of very slow growth, and takes three and a half years to attain its maturity; thus the fields will show the "*ichi-nen-shô*" (first year's growth), "*ni-nen-shô*" (second year's growth), "*san-nen-shô*" (third year's growth), and "*shi-nen-shô*" (fourth year's growth).

The "*ichi-nen-shô*," when fall comes around, has but two leaves and no stem; while the leaves, somewhat resembling clover-leaves, are egg-shaped and very much dented. The roots appear to develop much quicker.

The second year there appears a smooth stem, which at the top divides into two or three little branches. Last year's leaves are now finger-shaped, five in number, and symmetrically developed, especially the middle one, but no other change from the first year. The third year the plant half way up develops a wreath of clover-shaped leaves, the middle leaf of which is, like the second year's growth, slightly more developed than the rest; stem and branches are now of a nut-brown color.

The flower-bud starts from the base of the leaves, when a small flower appears, at times accompanied by a second one, slightly to one side or farther back towards the stem of the plant; but unless seeds are desired, and that not before the third or fourth year, these are pinched off. The seeds, after being gathered, are buried in the ground 1 to 2 feet deep, to preserve their germinating power.

The harvest takes place in "*Daya*" (July and August) the fourth year. The roots are cylindrical in shape, about as thick as a finger, white, and often prong-shaped towards the lower end. While fresh, they generally weigh 20 to 25 grams—seldom double that amount. After digging out the roots, they are freed from all dirt adhering to them and then carefully washed, after which they are scalded in boiling water or steam, so as to appear yellow-brownish, when the cross-insertion is made. They are then laid on shelves, and, according to size, exposed for two to eight days to a heat averaging 100° to 120° C., after which they are perfectly dry and fit for market. They may also be successfully dried in the sun.

When ready for market it is yellow or brown, semi-transparent, brittle, and of bitter-sweet taste, and must be guarded against dampness.

Of the stem and leaves is prepared a jelly which in taste reminds one somewhat of licorice; still it possesses a bitterish taste. This is never exported.

For the prepared ginseng-root is paid "5 to 7 yen per kim" ($5 to $7 per pound, or

600 grams), while in China 10 yen is the price. Manchooria ginseng-root is still more valuable, and is often paid its weight in silver six or eight fold. It is exported yearly to China, the revenue derived therefrom amounting to $180,000 a year.

EUCALYPTUS GLOBULUS.

We have been favored with a communication from the consul of the United States at Brussels, Belgium, containing a description of the *Eucalyptus globulus* tree, and a translation of an article respecting it from a French agricultural journal, with a suggestion that the tree might be advantageously introduced into the southern territory of this country. We are under obligations to the consul for his thoughtful attention to the interests of agriculture and of forestry in this country. It is obvious, however, to remark, in view of his suggestion in regard to the *Eucalyptus*, as well as of the very frequent inquiries which are addressed to us on the subject from almost every section of the country, that the department has long been familiar with the origin and history of the *Eucalyptus*, with its introduction and naturalization in Europe and Africa, and with its botanical character, economic value, and medical properties. Fifteen years ago the department took measures for its introduction into this country, and from that time to the present it has imported seeds directly from the habitat of the tree in Australia and distributed them freely in those portions of the country in which there was any likelihood that the climatic conditions would admit of its successful culture. With the exception of California, the experiment of cultivation has been generally unsuccessful. The tree has been found to be tender and incapable of enduring the frosts to which most even of our Southern States are occasionally liable. In California the result has been eminently successful, and large forests of well-grown and thrifty trees now exist there.

LOCUSTS IN SOUTHERN RUSSIA.

The department has received, through the legation of the United States at St. Petersburg, an official report, published in Russia, upon the subject of locusts in the southern portion of that country. This report, it was believed, would be of interest to American agriculturists, more particularly in connection with the grasshopper plague so prevalent in some of our Western Territories. It appears that Mr. Portchinsky, secretary of the Russian Society of Entomology, was sent to the southern provinces of the empire to ascertain in what places grain locusts (*Anisoplia austriaca*) preferred to lay their eggs, and that, having made numerous researches in the province of Pultava, he came to the following conclusions:

The grain locust generally deposits its eggs in wheat fields, and as soon as they are hatched the attacks of the insect on the grain commence.

There are generally from twenty to fifty locusts per square archine (an archine is 27 inches) of wheat. Rye and barley fields contain comparatively much fewer larvæ (from two to five) a square archine, but if these fields are near wheat fields the larvæ are then just as numerous. The fields which have been sown with wheat the preceding autumn are the receptacles of an immense quantity of larvæ, which it is impossible to destroy before they have become chrysalides.

The state of the fields whence the owners have driven the locusts is very different. The pursued insects fly in masses to the neighboring fields, and if the wheat field where they have fought these insects does not retain more than three to sixteen larvæ a square archine, on the other hand all the fields of flax, buckwheat, oats, &c., which are not generally attacked by the locust, become infested and contain from sixteen to twenty-six larvæ an archine.

It follows that the use of ropes or machines to drive away the locust is very danger-

ous, because, instead of laying their eggs in wheat fields, where they may be destroyed in the spring while in the state of chrysalides, they light upon the surrounding fields, no matter what they are sown with. Experiments made on the spot by Mr. Portchinsky prove that the larvæ turned up by the plow re-enter the earth quickly, but if they can be kept exposed ten minutes to the sun they infallibly perish under its heat. He concludes that in the spring, when the larvæ (become chrysalides) are in a state of complete immobility, plowing the fields will be of great use, because the chrysalides, exposed to the action of the sun, will certainly perish.

As to fighting the locust by destroying its eggs, Mr. Portchinsky considers this as impossible, inasmuch as the period during which the eggs remain in the ground before they became larvæ is precisely that during which the grain is standing.

Mr. Portchinsky is convinced that this year the locusts have left only an insignificant number of larvæ, which encourages the hope that the crops of 1881 will run no serious risk in this respect. As regards next year, according to the researches he has made, the fecundity of the locust has been very great. He calculates that, as the wheat fields of last year contained twenty to fifty larvæ a square archine, we get, counting only an average of thirty larvæ a square archine, a total of 648,000 locusts to the "deciatine" (.37 acre). In the village of Krontoyar, where the wheat fields cover 200 deciatines, each archine contained at least fifty larvæ. It follows that these 200 deciatines will contain next year more than 2,000,000 of locusts, and that consequently, if the next spring is favorable to the increase of this insect, great ravages from it may be expected.

ROUMANIA MAIZE.

We have received from the consul-general of the United States at Bucharest, in Roumania, a dispatch respecting the Roumanian or Moldavian maize, with a suggestion as to the desirability of introducing it into this country. We were aware that the maize of Roumania was a principal product of that country, and that it was exported largely to the different States of Europe, where it commands a high price as compared with American corn. But the peculiar value of the Roumanian corn is believed to consist in its especial adaptability for bread-making rather than in its usefulness for general purposes. The corn of this country which is exported to Europe is that which is raised for stock-feeding. We have many varieties, which are cultivated for breadstuff and home consumption, which would compete successfully in European markets with that of Roumania, but which do not invite attention as a staple or commercial crop. In view of the large number of excellent varieties of corn in this country, which, for all desirable qualities, are not inferior to any that is produced elsewhere, it was not deemed expedient to introduce the culture of the Moldavian corn, as proposed. We have in the museum of the department a variety of specimens of foreign corn, including some from Turkey, but none from Roumania. We have accordingly solicited from our correspondent samples of the different varieties of the corn of that country to add to our economic collections.

LAURUS FROM CHINA.

The consul-general at Shanghai has forwarded to the department a package of seeds of a species of *Laurus* from Western China, which, we regret to say, were not received in a good condition, being apparently so much decayed as to render it doubtful whether we shall succeed in making them grow. These seeds were sent, through the consul-general, by Mr. C. Colbaine Baber, formerly British resident of Yung Ching, but now Chinese secretary of the British legation at Peking. They are said to grow in Western China to a height of over 100 feet, and to furnish straight balks of excellent close-grained timber from 2 to 3 feet in diameter, which is locally employed in the construction of bridges and for the bottom planking of river junks. The tree flourishes on hill-sides from 1,000 to 5,000 feet above the sea, the annual range of temperature

in such situations varying from a little below freezing point to some 90° Fahr., the climate being exceptionally damp. Rain falls on or about one hundred and twenty days in the year, and there is no especially dry season. The tree is a native of the province of Szechune, where the local name is *Nanmu*. The timber is valuable for its durability. The large pillars at the Tamlis of the Mings are of this wood; and although they have been erected in their present positions for more than three hundred years, yet they are perfectly sound. The tree is tall and straight, without limbs or twigs until the top is reached, when the branches form a kind of canopy. The bark is of a gray ashen color.

LAURO-CERASUS AND LAUREL WATER.

We have received an inquiry from a correspondent in the State of New York for seeds or young plants of *Prunus Lauro-cerasus*, and for information as to whether the cultivation of that plant had ever been successfully accomplished in our northern latitudes. We have answered unhesitatingly that neither seeds nor plants are procurable in this country, and that it is very certain that the tree cannot be successfully cultivated in our Northern States. We had two or three plants that had been growing several years in the grounds of this department, experiencing more or less damage from cold and frost every winter, till at last, during the severe weather of the last winter, they were killed to the ground. The plant may be cultivated at the South, and indeed has been, but we know not to what extent. Its commercial value would be trifling. The watery solution of the volatile oil of the plant, called "laurel water," which is found among our drugs, is imported from the South of Europe.

PHYLLOXERA IN SPAIN.

The department received from Mr. Lowell, while minister to Spain, the information that the dreaded phylloxera had made its appearance in Spain, having shown itself in the neighborhood of Malaga, and being reported also in some parts of Catalonia. Referring to the destructive presence of the insect in France, where it reduced the acreage of land in vineyards by something over one-third, and where, in spite of the offer of large rewards, no effectual way of checking its progress has been discovered, Mr. Lowell remarks that it was feared that in Spain, with laxer habits of administration, it might prove even more disastrous. Mr. Lowell remarks:

> The universal depression of business is felt, perhaps, more severely in Spain than in any other country, and the destruction or diminution of a branch of industry so important as that of winemaking, would be a national calamity. Besides the great exportation of the wines of Xerez, there is another, perhaps even greater, of the rough Catalonian wines to France, whence, after manipulation at Bordeaux, they are distributed to the rest of the world as genuine products of the Bordelais. The ravages of the phylloxera in France and favorable changes in the tariff seemed likely very much to increase this trade, and accordingly, should the evil spread, it threatens to have a very serious effect on the prosperity of a country overburdened. The remedy thus far proposed, and, in part, adopted as most effectual, is the uprooting of a belt of vines, in order to isolate the infected district. But the weakness of this method lies in the natural temptation to conceal the existence of the evil on the part of small proprietors dependent on their patches of vineyard for subsistence. On every account it is to be hoped that Spain, whose resources would be greatly strengthened by a few years of regular government, may not be the victim of a misfortune which, by increasing the already great misery and discontent, might lead even to grave political consequences.

From Mr. D. T. Reed, of the same legation, the department subsequently received information that a congress, for the purpose of adopt-

ing such measures as might be thought best to prevent the spread of the phylloxera among the vines of Spain, had been for some days in session at Saragossa. The congress was presided over by the minister of fomento, and was composed of many men well known for their scientific accomplishments and as grape-growers. It closed its labors by adopting resolutions to extinguish the focus (*los focos*) by means of insecticides; in case this should prove insufficient, to try the American vines; to form nurseries of hard and resisting vines, and distribute the vines among the vine-growing districts, endeavoring at the same time to ascertain the conditions that would best adapt them to each locality; to allow in the infected districts the free introduction of American vines; and, finally, to ask the government to reform the law now in force in regard to protection against the disease.

PROGRESS IN CARTHAGENA.

The department has had some correspondence with the commissioner of agriculture in Carthagena, United States of Colombia, in which the gratifying intelligence has been communicated of something like a new departure in respect of agricultural industry in that country, hitherto retarded and depressed by untoward influences, now fortunately removed. A department, or central bureau of agriculture has been established, from the officers of which this department has received and cheerfully responded to a request for an interchange of seeds and such information as may conduce to the benefit of both countries. The president of the bureau, in a letter which has been included in our correspondence, expresses sentiments of respect and very cordial sympathy towards our republic and its agricultural and industrial institutions. We quote a few remarks from his letter:

> Colombia is a nation favored with a variety of climate, with great navigable rivers, extensive forests, excellent ports in both oceans, and many other natural advantages. But it is now that she is free from many obstacles that obstructed her path, and is thinking seriously of agriculture, the great element on which she can count her prosperity. In this section of the country you can be assured that this is the sentiment of all the people; and in following this new road, very naturally nothing can be more pleasant than establishing relations with a government that at all times has invariably practiced the great principle, that a public administration should never lose sight of production, because on that depends peace, power, and the welfare of all society. We are possessors of immense and unknown riches and precious articles, not only in the animal, but in the vegetable and mineral kingdoms. We can well say that the great part of America is unknown to science; and it is the duty of those who care for the welfare of humanity to facilitate all investigations that enable the wise to penetrate the secrets of nature.

STOCK FARM IN CHINA.

We have received an interesting dispatch from the United States consul-general at Shanghai, in relation to the establishment of a stock farm by the viceroy of the province of Chili in China. The consul-general had previously pointed out a method by which the Mongolian herds could be greatly enhanced in value, by the establishment of a farm at some convenient locality, where fine stock, horses, cattle, sheep, &c., could be bred. He now reports a very satisfactory interview with his excellency Li, the viceroy of the province of Chili, in company with a gentleman from the State of New York, a breeder of blooded stock, who strongly recommended the establishment of such a stock-farm as had been suggested. Through the active interest and influence of the viceroy, such a farm has been established by Mr. Tang King Sing, an able

and progressive Chinese mandarin, who being convinced of the superiority of Western ideas, did not hesitate practically to acknowledge it. His farm consists of about 5,000 acres, near the Kaiping coal-mines, now being opened by foreign engineers under his superintendency, situated about 80 miles to the north of Tientsin. In the promotion of this enterprise it is Mr. Tang King Sing's object to afford his countrymen an opportunity to become possessed of at least a portion of the science already attained by Western nations, in the improvement of their breeds of cattle. He has already ordered from this country twelve or fourteen fine merino sheep, for his farm, in order to test the practicability of the suggestions which have led to his undertaking.

ADULTERATIONS OF FOOD.

We have had frequent communications respecting the adulteration of foods, in respect of which our correspondents err in presuming that the remedy therefor lies with this department. Inquiries are made whether, if there be no more ready remedy, it is not within the power of Congress to pass a stringent law making it a crime to manufacture spurious articles or to adulterate genuine ones. Admitting the subject to be one of great and universal interest, we have only been able to say to our correspondents, that under the present standard of commercial morality, nothing is safe from adulteration; that the action of the general government is limited to imported articles, and chiefly to drugs; that the power of the government ceases with the custom-house; and that the general regulation of the subject is left to the several States, in most of which there are laws designed to remedy the evil, which, however, can only be done effectually by a rigid system of inspection. Merely prohibitory laws are of little value against human ingenuity and cupidity.

MARKET PRICES OF BUTTER IN HAMBURG FOR A PERIOD OF ONE HUNDRED AND FORTY-FOUR YEARS.

The department has received through Mr. Wilson, the consul of the United States at Hamburg, a copy of a work of curious interest, whatever may be its commercial and agricultural value, being a statistical statement of the market prices of the better qualities of Mecklenberg and Holstein butter for a period of one hundred and forty-four years, from 1736 to 1879, compiled from original quotations of prices actually paid for wholesale and export. The principal outlines of this compilation are drawn on three beautifully executed tables, showing the market prices in question from quotations of the Hamburg chamber of commerce, and calculated from annual average prices and from the highest and the lowest prices paid in each year. The tables also contain statements from reliable information received from farmers in Mecklenberg, as to the periods during the last twenty-two years, when cows were pastured or stall-fed, whereby it is definitely stated when stall-fed and grass butter were respectively produced. We have examined these tables with curious interest. The work is a remarkable one, and must have cost the compiler a vast deal of patient and skillful labor. We shall preserve it for the observation of our agriculturists, and especially those engaged in the dairy business and butter trade, who, we are sure, will not regard it with indifference.

SORGHUM AS A SUBSTITUTE FOR SUGAR-CANE.

The following is an extract from a letter of Mr. James L. Lobdell, of West Baton Rouge, La. It will be seen that he takes rather a dis-

couraging view of the condition and prospects of the sugar-cane industry in that portion of the State, chiefly from the adverse climatic influences to which it is liable, and suggests that sorghum would be a reliable substitute for the cane for the manufacture of sugar:

I have the pleasure of acknowledging the receipt of a copy of your Report of the Department of Agriculture for the year 1879, which I greatly appreciate, and which I have read with much pleasure, especially that part referring to the different kinds of sorghum as sugar-producing plants. Being very extensively engaged myself in the culture of sugar-cane and the manufacture of sugar, having all the necessary sugar machinery, I am desirous of making an extended and careful experiment of sugar sorghum, and as you have exhibited so much interest in the improvement and the encouragement of the cultivation of sugar-producing plants, I take the liberty of addressing you in this interest, and will give you some of the reasons why I desire to try effectually this experiment:

First. On account of the great difficulty and uncertainty of saving seed from the sugar-cane in this State. It is liable to be injured from different extremes of the weather, either too cold, wet, or too dry, and often causes entire failure of crops, both stubble and plant.

Secondly. The value of the seed and expense of saving it. It requires about one-seventh of a growing crop annually to be put down for seed in mats or windrows for the following crop at a heavy cost, and at the busiest time of the year, that of harvesting the crop.

Thirdly. The great expense of planting the cane itself during the spring of the year, and the difficulty of replanting should the stand be bad.

Fourthly. The expensive cultivation of sugar-cane after it comes up.

I am of the opinion that sorghum or any sugar producing plant that can be ground from the seed as a substitute for our Louisiana sugar-cane, although not quite so productive, would be a more certain and remunerative crop; in part on account of the above-mentioned reasons and many others which I will not now occupy your time in discussing, but will after due trial and further investigation give you my experience.

BELGIAN IMMIGRATION.

Mr. Wilson, United States consul at Brussels, writes to the department that a large number of young and robust Belgians, many of them farmers possessing more or less means, have applied to him for information concerning the agricultural lands and other resources of the United States, with a view to their emigration from Belgium. The department has, as far as practicable, supplied the desired information, by furnishing directions for immigrants, as to the prices and conditions of sale of public lands, the principal productions, the means of communication with markets, the classes of workmen most in demand, &c., including information as to the manner of proceeding to obtain title to public lands under the homestead and pre-emption laws. The consul states that, as a rule, Belgian farmers, grazers, and skilled mechanics are a sober, industrious, and thrifty class of men; but that until quite recently few of them have manifested any desire to quit their country. Now, however, they seem to have caught a new inspiration, and in very considerable numbers are looking towards the United States for a wider and more remunerative field for their industry, and contemplating a large emigration of young, sober, and industrious men vastly superior, as the consul thinks, to the rank and file of those who go from other continental countries. Meanwhile, we are told that the lives of the working people of Belgium are continual struggles for meager existence, and that nothing but that spirit of patience, kindness, and fortitude which enables them to practice the severest economy, makes it possible for them to subsist themselves and supply the necessities of their families. Contentment among these working people, however, a fixed principle of living within their means, and a feeling of reciprocity between employers and employed, have made Belgium important in the agricultural, commercial, and manufacturing world. Belgium utilizes five-sixths of her lands, including

mountains and rivers. This emigration is suggestive. The question forced upon us is, whether it is any longer desirable to encourage immigrants of any class to come to the United States, to hasten the time when, like Belgium, the density of our population will prove anything but a blessing.

FLUKE OR SHEEP-ROT IN ENGLAND.

Mr. King, consul of the United States at Birmingham, has communicated to the department, through the Department of State, an account of the ravages committed among the flocks and herds of England by a parasite, well known in this country as the "fluke" (*Fasciola nepotica*), occasioning the disease commonly called the sheep-rot, and has forwarded to the department a very fine specimen of the parasite, mounted for use in a microscope, which has been deposited in our economic museum. This is a well-known disease, and few sheep-growing countries have escaped it. It does not usually become general, however, unless in seasons of continued wet or in badly drained pasture lands. Mr. King states that he has endeavored to procure fresh facts and figures upon the subject, but that his endeavors have been almost without result. The disease not being contagious within the meaning of the act of Parliament, no information has been collected and no official returns made, and the facts are said to be studiously concealed by the farmers. The epidemic in England appears, from the statements of Mr. King, to have continued longer than any previously recorded, owing, probably, to the fact that the past two summers have been so uncommonly wet. It began in the autumn of 1869 and has continued to the present time; it has spread over all of England and Ireland, but Scotland is believed to have escaped; it has increased in violence in the midland and southwestern counties of England, where, Mr. King thinks, if the farming had been better and the drainage more thorough, the disease would have been less fatal. In the midland counties the number of sheep at midsummer, 1879, was 4,486,990, and in the following spring the estimated loss was 1,237,000. In 1874 the official statistics gave the number of sheep and lambs at midsummer in England to be 34,751,554; in 1879 at midsummer the number was 32,237,598; in 1880, at the same period, the number was 30,239,620. This decrease was chiefly, if not wholly, due to the sheep-rot.

The same result is shown by the figures regarding the crop of wool gathered in England. In 1879 it was 153,000,000 pounds, and in 1880 it had diminished to 149,000,000 pounds. The ravages of the disease still continued at the last dates, and the pastures, formerly so populous, were comparatively deserted. The recurrence of a summer resembling that of 1879 and 1880, it was apprehended, would occasion such suffering, bankruptcy, and poverty in the agricultural districts as England has rarely if ever experienced, crops, flocks, and herds having all suffered; and there is no excess of one to smooth down the loss in another, nor is there any surplus left to keep the farmers going until the coming of better times.

PLASTERING OF WINE.

The department has been advised by the French minister of agriculture and commerce that the ministerial departments of France have taken up in earnest the subject of plastering wines, and that measures have been instituted to check or limit the pernicious practice. After a thorough examination of the subject, an advisory committee on hygiene,

appointed by the French Government, has given the following opinion of the plastering of wine in relation to public health:

The absolute immunity which has hitherto been enjoyed in France by plastered wines should no longer be officially allowed. The presence of sulphate of potash in wines offered for sale, whether it is due to the plastering of the must, to the direct mixing of plaster or sulphuric acid with the wine, or to the dilution of unplastered wine, should no longer be tolerated, save so far as to allow a maximum of two grams per liter.

This opinion having been approved by the minister of commerce, measures have been taken to prevent the sale in France of French or foreign wines containing a quantity of sulphate of potash in excess of the limit above prescribed. The new measure is to take effect in the month of August next. The French minister of agriculture deems it a matter of importance that foreign merchants should be informed in due time of the new condition to which the sale of wines from all countries is hereafter to be subjected in France, and likewise that parties interested in such matters in foreign countries should know what a careful study has been made in France of this question of the plastering of wines, and that the new measure has been adopted with a view to furnishing every guaranty of the wholesomeness of French wines.

BONUSES FOR AGRICULTURAL INVENTIONS AND IMPROVEMENTS.

The department is frequently appealed to by correspondents in various portions of the country, for pecuniary assistance, in the way of rewards, bonuses, or prizes, for alleged inventions, discoveries, and improvements in agricultural science, labor-saving applications, methods of culture, and general economy in farming industry. We are obliged to return negative answers to all such applications, and take occasion here to repeat, for general information, that pecuniary assistance in any form is beyond the province as well as the means of the department. We have no authority, under any circumstances, to make such grants as are referred to. The appropriations for the conduct of the department are definite, and for specific and limited objects, and cannot legally be diverted to any other than the expressed purposes.

BEET-ROOT SUGAR INDUSTRY.

The department is indebted to E. H. Dyer, esq., superintendent of the Standard Sugar Manufacturing Company, of Alvarado, Cal., for the following interesting and valuable letter on the subject of the beet-root sugar industry of this country:

Your several communications in regard to beet-root sugar, sugar, and sorghum are received. I am very glad that you manifest so much interest in the manufacture of beet-root sugar, and thank you for your kind offer to give your valuable aid in furthering the sugar interests of California. Prompted by the kindly interest you take in the success of this business, and knowing the powerful influence you can bring to its aid, I take the liberty to forward to you some of my views in regard to what should be done in order to place the business on a substantial basis, and also some of the principal reasons of the failure in this country in the past, and what we may reasonably expect may be a cause of a like result in the future.

In my opinion it will take many years for the beet-root sugar industry to be established on a large scale and paying basis here, unless Congress gives it encouragement by offering a bounty on all of this product that may be manufactured in the United States for a term of years. Some of the reasons why it will not increase rapidly enough to become of any importance for many years without such aid, are, that it is a well-known fact that all of the factories that have been established in this country up to the present date, with the exception of two that have been recently built, and have not had an opportunity to give the business a fair trial, have failed and been aban-

doned, leaving the future success of the business in great uncertainty. It is also well known that about the only class of sugar-makers that come to this country, with a very few exceptions, are Germans, and they, as a general rule, come here because they have not sufficient ability to succeed in their own country. They come here and hold out false inducements, and make erroneous statements in regard to the business, either through ignorance or design, in order to get employment, regardless of the interests of those they induce to risk their capital in these enterprises. It is not an easy matter to induce a good sugar-maker to leave steady employment in his own country and come to a country where another language is spoken, different habits prevail, and the business an experiment. As a matter of fact none of that class will come here unless a very large salary is guaranteed them—so large that very few would care to take the risk of paying it—in order to invest in a business that they know so little about.

Then, again, five years' experience in this business has taught me that much of the German machinery is not adapted to the manufacture of beet-root sugar in the United States, where labor is so high. It is not gotten up with a view to saving labor, nor with any proper regard to cost, neither are their factories arranged nor their business conducted with a view to economy in this particular. On the contrary, it appears that the more people required to run their factories the better they are suited. They seem to know but very little about economizing labor.

Now, under these circumstances, should it be a cause of wonder that this business has failed to be remunerative here? Should we be surprised when capitalists hesitate to invest in a business that, so far as they know, has proved a failure in every instance in this country? Yet, in the face of these disasters, I am informed that there are parties contemplating building several factories in different sections of the United States. There appears to be at this time great interest taken in the matter in all parts of the country, and considerable excitement. When we take into consideration the amount of sugar annually imported, this should not surprise us in the least, and the question naturally arises in the mind of every intelligent person that gives the subject any thought, Why do we import nearly $100,000,000 worth of sugar annually, when we have a soil and climate as well adapted to the production of beet-root sugar as any of these countries that are exporters of it? Taking this view of the matter, which on its face is a reasonable one, many factories, no doubt, will be built in this country in the next few years, and I am quite sure that many of them will be failures financially, and the consequence will be, in many instances, that the business will be abandoned in disgust. Capitalists, believing that there is no money in it, not understanding fully the causes that lead to failure, and not caring to risk more money to find out, will be only desirous of getting out of the business as easily as possible.

But should Congress offer a liberal bounty on all sugar manufactured from raw material produced in the United States for the next five or perhaps ten years, the case would be quite different. Capital would call to its aid the best mechanical talent of the country. Factories in foreign countries would be visited by practical American mechanics and engineers; modifications would be made in machinery, and in the general arrangement of everything connected with the business; American ideas would prevail, which would give the business such an impetus as would in a few years astonish ourselves, and in less than ten years we would be exporting sugar instead of importing it. For the few thousand dollars paid by our government to encourage the production of sugar within its own limits, it would receive as many millions in a very few years. It would be not only the millions of dollars paid to the sugar planters and manufacturers of foreign nations that would be saved, but the cultivation of the beet for sugar would increase tenfold the amount of other products in the same locality. Herds of fat cattle, extensive dairies, and abundant crops of all kinds would be the sure result.

My statement may appear a little inconsistent, that the only way to make this business a success in this country is by bounty. The point I desire to make is, that by giving a bounty the business by its aid will attain the necessary proportions to stop the annual importation of such enormous quantities of sugar in much less time than it otherwise would, thus saving millions of dollars to the country many years sooner than it would if left to struggle alone and unaided. That the business will eventually succeed, even if no bounty is paid, I have not the slightest doubt; but it will be after many years of struggles, disappointments, losses, discouragements, and failures.

Another of the great disadvantages we labor under is that we have to depend entirely on foreigners for our skilled labor, and, as a general rule, they are disinclined to instruct others. It is very necessary that Americans should learn this business, but in consequence of the present uncertainty of its success in this country, and the difficulty of getting the necessary instruction on the subject, very few can be found that care to go to the expense and trouble of learning it. But if the success of the business was assured, which would be the case if a liberal bounty were paid by our government, there would be no lack of intelligent and enterprising young men who would qualify themselves to conduct this business, and, as I believe, would leave the

"old fogies" of Europe so far behind in a few years that they would open their eyes in amazement.

So far as my knowledge extends, no factories have been built in this country that could be worked economically. The reason of this is obvious. Sugar-makers are not necessarily millwrights any more than shipmasters are shipwrights. But in this country, in the absence of millwrights that understand building sugar factories, we are obliged to rely upon the sugar-makers to superintend the construction of the works, and, however skilled they may be in their particular vocation, very few of them possess the requisite knowledge to construct in a proper manner a beet-sugar factory.

I am a pioneer in the beet-sugar business on the Pacific coast. I invested largely in the business ten years ago, and continued for four years with others trying to place the business on a paying basis, but failed to do so after incurring a heavy annual loss. In February, 1879, a company was formed and incorporated, in which I have an interest, to give the business another trial. We bought the machinery of an abandoned factory for a trifling amount, added to it all the latest improvements, contracted for an abundant supply of beets for $4 a ton; were fortunate in getting a good sugar-maker, after suffering loss in consequence of an incompetent one, and are nearly through our first campaign. We will probably not have to assess the stockholders at the end of the campaign, which has heretofore always been the case. Yet under all of these favorable circumstances, a very inadequate dividend will be paid, when the risky character of the business is taken into consideration.

I do not desire to discourage any one from taking hold of this business, as it must and will be a great success in this country, as all the elements of success are here; but I want all who contemplate investing in this laudable and interesting enterprise to understand some of the difficulties they will have to encounter, so that, if possible, some of them may be avoided. We expect to do better in the future, and I have no doubt we will, as we are daily gaining in the necessary experience. We are making as good sugar as can be made in any country, or from any product, and it meets with a ready sale. Our molasses is unfit for domestic use, and therefore a complete loss. Congress should allow this product to be manufactured into alcohol, which is the only way it can be utilized and be exempt from paying any revenue tax. In consequence of this tax we can make no use of it whatever, but are obliged to let it run to waste. I presume there is no one but will admit that it is wrong to be obliged to waste so much valuable material. In Europe the molasses is all distilled into alcohol, and is an important item of income. Another great disadvantage we labor under in this country is, that we have no thorough work in the English language on the manufacture of beet-root sugar. I have seen several works on the cultivation of the sugar-beet, but they practically amount to but little, as rules that apply to some sections of the country would not do at all in other localities. But a work in the English language, containing accurate drawings of all the machinery used in the manufacture of beet-root sugar, including all the latest improvements, also full instructions in regard to the manufacturing of it, describing in detail the chemical treatment and changes during its whole process of manufacture, or, in other words, a complete work on the subject, containing all that would be requisite for a person of ordinary intelligence and with the necessary amount of practical knowledge to thoroughly understand and conduct the business, is what is needed. The sale of such a work would be so limited is probably the reason that it has not been published.

I have endeavored to set forth in as brief a manner as possible some of the difficulties already encountered and liable to be met with in the future in establishing this industry in the United States, and indulge the hope that you may agree with me with regard to most of these statements, and may lend your valuable aid that the experiment may be brought to a successful issue.

DEPARTMENT OF AGRICULTURE IN JAPAN.

A communication from Mr. Bingham, minister of the United States at Tokio, Japan, conveys to us the interesting intelligence that a department of agriculture and commerce has been established by the government of that empire. The imperial proclamation to that effect is a remarkable, if not commendable, specimen of official brevity. We copy it entire, as follows:

Proclamation is hereby made that a department of agriculture and commercial affairs has been established.

SANJO SANEYOSHI,
Prime Minister.

PRODUCTIONS OF BERMUDA.

We are indebted to Charles M. Allen, esq., United States consul at Hamilton, Bermuda, for the following interesting letter on the subject of the productions of the Bermudas, or Somers Islands:

The Bermudas or Somers Islands, lying in latitude 32° 15′ north, longitude 64° 52′ west, consist of some fifteen islands partially susceptible of cultivation, and some two or three hundred smaller ones, many of which are little more than detached rocks, the whole having an area of about 12,000 acres, with little level surface, the whole surface of the country being broken by ranges of hills and detached hills, which are mostly covered by a small growth of cedar and sage-bushes, with the underlying rock near the surface or cropping out.

The whole sub-strata consists of a soft lime rock which appears to have been formed mostly by the high winds carrying the sand thrown up by the action of the waters, into the interior, where in the course of centuries it has become solidified and forms a soft stone which is used for building purposes, and can be easily cut with a saw.

Almost the entire products of the islands consist of Irish potatoes, onions, and tomatoes. In the year 1844 there were exported 261,062 pounds of arrow-root, valued at £10,974, while during the same year the entire exports, exclusive of arrow-root, amounted to but £2,943. In 1850 the value of arrow-root exported had fallen off to £3,536, and at the present time has almost ceased to be an article of merchandise. In 1876 the invoiced value of arrow-root shipped to the United States was but £75. In the year 1850 there were exported from this colony, mostly to the West Indies and Demerara, in value, potatoes, £1,671; onions, £1,820. In 1855 there were exported, onions, 812,330 pounds; 7,715 boxes of tomatoes of about seven quarts each, and 23,840 pounds of potatoes, the larger portion being sent to a southern market. In the year 1861 there were exported 824,943 pounds onions, 45,675 boxes tomatoes, and 24,252 pounds potatoes, 15,875 of which were sent to the United States, also nearly the entire export of tomatoes, and a large share of the onions.

From the year 1861 to 1867 the products of the colony showed no perceptible increase, owing principally to the diversion of labor from agriculture to the interest of blockade running, and after the close of the war to the unwillingness of laborers to return to agricultural pursuits at anything like former wages.

The exports of 1870 were 5,433,000 pounds onions, 45,675 boxes tomatoes, and 10,127 pounds of potatoes. Total value, £34,943. About this time the colony entered into a contract with Wm. H. Webb, of New York, for steam communication between the ports of Hamilton and New York, once in three weeks, the colony paying a subsidy of £5,000 annually. Before steam communication the planters had to ship in sailing vessels which often made long passages, and their produce was liable to great deterioration, and not infrequently was landed in New York in a worthless condition.

From 1870 to the present time the agricultural products of the country have been increasing until most of the land worth cultivating has been utilized, there being only about one-eighth of the whole area (or 1,500 acres) that can be used for the growth of vegetables; that lying in detached pieces in the valleys or in sheltered places, and not often more than one or two acres in a piece. The land is largely owned by small planters, who use every rod they can. The hills, which comprise the greater part of the area of the islands, have not sufficient soil, and being exposed to the high winds of the winter months, cannot be cultivated. They are mostly covered with a short, brittle grass, which stands the summer droughts, and are useful for timber and pasturage.

The invoiced value of vegetables shipped to the United States alone from Bermuda during the first six months of this year (1877), which includes all the shipping season, amounts to £67,000, and as they found a good market, the returns cannot fall much, if any, short of $450,000. Several cargoes were shipped to the West Indies and Demarara. No seed is grown here. The onion seed is all imported from Madeira and Teneriffe, the latter place principally, as it produces a milder and earlier onion. The seed is sown in beds in October and November, and transplanted to the field in December and January, and set about 6 inches apart. A large portion of the ground is prepared with the spade. Among the larger planters, however, the plow is mostly used at present, although a few years ago it was almost unknown, and many are now to be found who think it injures the ground.

An acre planted in onions under favorable circumstances will produce 500 boxes, of 50 pounds net each, which usually return the producer from $1 to $2 per box, though the New York market, to which most of the produce is sent, is extremely variable. The onions in the field are usually weeded by hand once or twice during the season. The cost of growing and preparing for market, exclusive of land rent and boxes, will not, as a rule, exceed 3*s.* per 100 pounds.

The soil in the valleys is mostly dark red, and produces well the first year without manure, but soon becomes exhausted unless fertilizers are applied at every crop. Sta-

ble manure is generally used, but cannot be obtained in sufficient quantities. Guano is not used to a great extent, as it is believed to injure the soil for the following year. Fish guano and various other fertilizers are imported from the United States, but, as they are expensive, they are avoided when possible.

One of the greatest drawbacks to the thorough cultivation of the soil is the want of good laborers. Several importations of laborers from Sweden have been made at the expense of the colonial government. They have usually come under contract to remain two years, but the experiment has not proved a success, a large portion having become dissatisfied and gone away without fulfilling their contract, and leaving the planters to depend upon colored laborers. The latter, as a rule, do not like steady work, particularly agricultural; and, although they are comparatively poor, they prefer to obtain a livelihood by fishing and other means than by steady work. The price of day labor in the soil is about 3s. sterling per day, without board, or £20 per year, with board. The planting for market is wholly done in the winter months. Potatoes are cut, leaving one eye in each piece, and are planted in January in drills, 18 inches apart, with seed about 5 inches apart in the drills. Eighty barrels to the acre is a good yield, or ten to one, though sometimes fourteen or fifteen to one is obtained. The blight, or potato disease, often greatly injures the crop. Formerly the Western Red was planted, but of late years the Garnet has taken its place, as they are less liable to disease. The Early Rose and some Bermuda seed are planted in the months of September and October for an early crop, but the yield is small, not averaging more than four to one. They are out of the ground in time for the principal crop in January.

Sweet potatoes are grown during the summer months for home consumption, and are an important article of food for the inhabitants, but the quality being inferior to the American ones they are never exported. Vegetables for home consumption are but little cultivated, and it is rarely one will find other vegetables on a Bermuda table than onions, potatoes, and tomatoes in their season. Insects are very troublesome to most garden vegetables, and there is more profit in using the land for the principal crops. Most of the tropical fruits grow here, but are not to be had in abundance. Of late years the orange crop has failed from the effects of an insect. The trees are mostly dead, and it is seldom any native oranges can be found in the market. Bananas are more plentiful than any other fruit, are of a superior quality, and are nearly all consumed here.

Land is worth about £35 an acre on an average, but good planting land is worth £200 to £300 per acre, and is rarely in the market.

TREATMENT OF COTTON SEED WITH SULPHURIC ACID.

A recent suggestion was made by the microscopist of this department that by treating cotton seed with a preparation of sulphuric acid the removal of the fiber might be accomplished without injury to the germ, and thus adapt the seed to more convenient, economical, and effectual planting. The discovery of what, if it prove ultimately successful, will be of great advantage in the production of the staple, has led to several inquiries from cotton planters for a description of the process employed by the microscopist under whose investigations and practical experiments the discovery has been made. In answer to these several inquiries we have forwarded to our correspondents a brief statement by the microscopist, as follows:

To one pound of cotton seed add about two ounces of strong sulphuric acid of commerce, mixing the mass intimately with a stick. Should the mass appear wet, more seed should be added. The acid should be dried up by the seed, care being taken that every seed is made moist with acid. In a few minutes the lint will be converted into a paste, which is quite soluble in water. Wash the seed now in a clear solution of lime-water, in which the light and worthless seeds will float to the surface, while the plump and sound ones will sink to the bottom. After removing the floating seeds the sound ones should be washed in pure water, the washings being saved for fertilizing purposes. About one-sixth of water may, in the outset, be added to the sulphuric acid. The object in using strong acid is to remove the lint more quickly. When water is mixed with sulphuric acid the mixture heats, and for the purpose desired it should be allowed to cool before adding the cotton seed. The vessel used should be acid proof, as a stone or glass basin, or a wooden box lined with sheet lead. Tin or iron will not answer. Seeds thus treated should be kept in a dry place. Seeds planted eight months after treatment have grown well.

The following letter from an intelligent planter in North Carolina, to whom an opportunity was afforded of testing the efficacy of the process, exhibits very satisfactory results, if it may not be regarded as conclusive as to value of the discovery in question:

HERTFORD, N. C., *May* 27, 1881.

DEAR SIR: I send results of cotton seed treated with sulphuric acid, as per instructions furnished by the microscopist of your department. Planted seed, treated with the acid, by side of those unprepared May 13, ground very dry and no rain since. May 21, those prepared were up to a stand, while the others not one in ten up and will not come until it rains. Some of the advantages of the prepared seed are:

1st. A saving of at least one-third of the seed.

2d. The more even distribution of the seed in planting; and the fewer seed and more even distribution the less trouble in thinning out.

3rd. Less bulk in handling, and time saved in filling planter, &c.

4th. In planting by hand they can be put just as you want them, while the others stick together.

5th. They can be planted with any ordinary corn-planter.

But the great advantage is the quick germination in dry weather. There has been great loss in this section for several years from failure to get the seed up in time. We have had rains in April to bring up the seed early planted, but none in May; and the cotton frequently not up till June. Such is the case now.

Formerly May was a wet month, but of late years the reverse. May it not be attributable to the fact that formerly there was more small grain and pasturage, and fallowing and later planting, and but little radiation of heat from the surface of the land, while now the lands are bare of vegetation at this season, and such great radiation of heat as to disperse instead of condensing the clouds, and that we may look out for a dry May hereafter. If so, your discovery is very valuable.

I have waived the consideration of the quicker germination with favorable seasons, as every farmer knows that the sooner it is up so much it has the start of the grass.

Very respectfully, your obedient servant,

R. B. COX.

HON. W. G. LE DUC,
Commissioner.

COFFEE IN FLORIDA.

It is known that coffee has been produced in Manatee county in Florida, samples of which are exhibited in the museum of the department. The seed thus brought to a bearing state was obtained from Cardova, Mexico, five or six years ago, and the result obtained, through careful culture, by Mrs. Julia Atzroth, of Togartyville, Manatee county, Florida. From our correspondence on the subject we have learned that the two trees from which the coffee in question was gathered were planted in 1875, and that in four years they were full of berries of different sizes, some ripe, and others half grown, and others still in the bud. Mrs. Atzroth, under date of September 22, 1879, writes that—

One of the trees is 6 feet high, has eighty branches, and measures 16 feet around the tips of the lower branches, and 3 inches around the trunk, the berries hanging in clusters of five and six, from 1½ to 2 inches apart, the leaves being of a beautiful glossy green.

Mrs. Atzroth has other young trees, not yet in bearing, planted among banana trees for protection from cold and wind. She protects the trees still further, in winter, by sticking pine tops around them. She resides on the south side of the Manatee River, three miles from its mouth, where frosts seldom occur and where the water is salt, producing considerable warmth in winter.

At a subsequent date, February, 1880, Mrs. Atzroth writes that the two large trees above mentioned are in full blossom and promise an abundant crop, and that her three-year-old trees are also in bloom and full of buds. A recent letter from Mrs. Atzroth informs us that she con-

tinues and is extending the cultivation of coffee with success. She has raised a good many plants from her own seed and has quite a number of plants which she has received from this department, all in a flourishing condition and promising very satisfactory results. Experts who have been familiar with coffee culture in Mexico and India have examined her embryo plantation and pronounced it a success. The yield of her bearing trees is quite large and, with further experience of culture, she is of opinion it may be considerably increased. She expects a fair crop from trees the plants of which were sent her from this department two and a half years ago. Although the last winter was exceptionally severe, Mrs. Atzroth remarks that her coffee trees have remained altogether uninjured. On the whole, she expresses entire confidence of the final success of the experiment of coffee growth in Florida.

CULTURE AND MANUFACTURE OF TEA.

The efforts which the department has inaugurated for the cultivation of the tea-plant and the manufacture of tea in this country have led to a voluminous correspondence with persons in different parts of the country, and to a universal expression of interest in the enterprise and of confidence in its ultimate success. We subjoin a few extracts from this correspondence, and likewise a report upon the experimental tea-farm established by the department in South Carolina:

DEAR SIR: I send you the proceeds of our second leaf-picking, by express, to-day. We have had quite a satisfactory gathering on this occasion, and it would have been even more so had I been able to have come down earlier and picked off the leaves at the proper time. They had got out rather far and were consequently hardish. It is all we can do to take them off fast enough. We have been obliged to tear off and throw away quantities of overgrown leaves. The plants under shade continue to give the highest yield, but all those we have mulched are not far behind. The mulched plants probably give most shoots, but the sun hardens them quicker than the shade. I used four different kinds of manure, but cannot say I see much difference in either quantity or quality of leaf. I don't mean to say the plants are not yielding better for being manured, but, so far, one manure seems to be as good as another. The oil-cake has killed about a dozen five-year-old plants, having been applied too freely and too near the stems.

All our transplants of last November, both small and great, have come on very well, but the seed I put down in November has astonished me beyond anything I could have expected to see; our transplanting of the present spring is not doing so well.

Our labor continues to give every satisfaction, particularly the leaf-pickers, who are now gathering about double the quantity of leaves they did last year. They are getting into the way of it much better.

I have not been able to give you the pure Japanese brand for want of a boiler and suitable trays, but if, after inspecting these new kinds, you still desire them I will get the necessary appliances. There are five distinct classes of teas in the eight tin boxes, and I wish it to be well understood that I can materially improve upon them all, and all I want to know meantime is whether I am on the right tack or not. The ordinary formula of eastern tea manufacture does not hold good in some respects here. There were two points I kept steadily in view, viz., strength and the feasibility of manufacture by machinery. There is no use preparing high flavored fancy samples, such as we can never manufacture to a profit. As the dealers will see at a glance, these are no fancy samples, but are made from coarser leaves than either Chinese or Japanese teas. I have aimed to develop strength on this occasion, regardless of flavor or appearance. The complaint of the last muster was want of strength. Once I can satisfy you on that score, I can easily add flavor and fragrance. My objection all along to the manufacture of green tea has been the expense, seeing it could not be done by machinery. I wanted to make black tea because we could use machinery. I was under the impression that green teas could only be made by hand, and certainly they have never been made by any other method up to the present time. But I have no hesitation in saying that I can manufacture better green and Oolong teas by machinery alone than it is possible for any skilled laborers to do. I have discovered that much in my experiments here. I have sent you a small quantity of black tea just to show the contrast in liquor between the different assortments. I tried to flavor this sample a little with the aroma from myrtle, but it is scarcely perceptible. These teas are, as

you will see, altogether different from anything I have heretofore sent you. They will, I trust, please the trade somewhat better than the black fermented kinds. I hope to send you a sample of tea made from the Indian plant as soon as I get back to Summerville. The demand for seed and plants is growing extraordinarily.

I am, yours, very respectfully,

J. JACKSON.

Hon. W. G. LE DUC,
Commissioner of Agriculture.

DEPARTMENT OF AGRICULTURE, *Washington, June* 13, 188 .

GENTLEMEN: I forward you another muster from second picking of this year's tea, which I will thank you to submit to the judgment of Messrs. Beebe, Montgomery, and others to whom were submitted the samples of black teas which were made from the first picking of this year's leaves. You will notice that Mr. Jackson has made these teas in accordance with the suggestions of yourselves and the other gentlemen who were pleased to examine and advise as to the other samples submitted to them. You will observe in the letter of Mr. Jackson, a copy of which is herewith forwarded for your notice, that he sends five distinct classes, and wishes to know from the dealers if any or all of them indicate progress in the right direction to meet the American market.

As this is the last time, as Commissioner of Agriculture, I will have occasion or opportunity to submit any samples of American-grown teas for your judgment and for my information, I desire to thank you and, through you, the other gentlemen connected with the tea trade in New York city, who have, on several occasions, kindly favored me with their examination and opinions of the various sample teas, much to my encouragement in this attempt to establish a new agricultural industry by which many millions annually will be gained by our country.

Of the permanent establishment of tea-growing, a very profitable agricultural employment in the United States, I think there can no longer be a reasonable doubt. Again thanking you all for your hospitality in opening your offices for my use and granting me every facility,

I am, respectfully, your obliged servant,

W. G. LE DUC,
Commissioner of Agriculture.

A. A. LOW & BROTHERS,
97 *Wall street, New York.*

NEW YORK, *June* 22, 1880.

DEAR SIR: We beg now to give you the joint opinion of Messrs. Beebe & Bro., Messrs. J. J. R. Montgomery & Co., and ourselves as to the respective merits and demerits of the various samples of Mr. Jackson's last experiments with American-grown tea, placed before us by your good self for examination.

The sample in bottle made into gunpowder tea makes a light liquor and has genuine green-tea flavor, but lacks strength, or rather it needs more firing to give it a richer flavor and add apparent strength.

Sample A makes a light liquor and has a fair amount of strength; it resembles in leaf and flavor fine "Orange Pekoe." This description of tea, which possesses good drinking qualities, is not likely to be popular with the mass of consumers.

Sample B made into Young Hyson shape, has fair strength, makes a light liquor, and has a flavor resembling China Moynne greens. With this sample, as with the sample made in gunpowder, a little more firing will improve the flavor and add apparent strength.

Sample C makes the same light infusion as the others and lacks strength, but will sell as an ordinary grade of green tea; more firing will improve it.

Sample D is undesirable in make and quality.

Sample E not likely to suit popular taste.

These teas, as a whole, are a vast improvement on anything we have yet seen of American growth. If they can be produced in quantity with quality equal to the samples shown us, we have no doubt that when presented to the public they will meet with ready sale.

We are, dear sir, very truly yours,

A. A. LOW & BROTHERS.

Hon. W. G. LE DUC,
Washington, D. C.

NEW YORK, *May* 14, 1881.

DEAR SIR: I am in receipt of your favor of the 12th instant, together with a copy of Mr. Woodward Barnwell's letter and sample of "pure tea" raised by him near Savannah, Ga., and note Mr. Barnwell's inquiry as to the merit of the tea.

I have carefully examined his sample of tea, which, in its purity, fineness, and delicacy of leaf, certainly indicates it to be the product of a fine quality of the tea plant.

The appearance of the cured leaf is handsome and resembles a "black leaf Pekoe" —one of the so-named black teas—giving a clear and delicate infusion, so much so as to appear to be wanting in strength, which deficiency I do not judge to be inherent in the plant, but probably the effect of insufficient firing.

While the result of Mr. Barnwell's labor has been to produce so good a *black tea*, which under the names of "Congou," "Souchong" or "Pekoe" forms so small a part of the whole consumption of tea in the United States, I would suggest the experiment be tried for making "Oolong" or "Japan" tea, for which the leaf of his plants appear to be well adapted.

For Oolong tea less fermentation of the leaf is required than for the Congou, &c., and for the Japan little or no fermentation is necessary. The leaf, in both of these forms, requires more firing than Mr. Barnwell's seems to have had.

In Japan the time given to firing the colored leaf is sixty to seventy minutes, and some less time to "basket fired" style, which is the leaf prepared without coloring.

Very respectfully,

H. B. WATSON.

WILLIAM G. LE DUC, Esq.,
Commissioner of Agriculture.

P.S.—While it is somewhat a matter of *fancy* as to the value of Mr. Barnwell's specimen of tea, I estimate the value nominally at about 30 cents per pound.

NEW YORK, *May* 14, 1881.

DEAR SIR: Your favor of the 12th instant, with sample of tea produced by Woodward and Barnwell, together with copy of their letter, reached us yesterday. We have carefully examined the sample of tea, and find it decidedly superior both in leaf and flavor in the cup to the specimens submitted to us last week. It is not remarkable for strength, but the infusion is delicate and decidedly more palatable and better adapted to the taste of American drinkers. If imported from India or China, it would be classed "fine black-leaf Pekoe."

The leaf as to shape and color is very attractive. Nevertheless, tea prepared in this way cannot, without great change in the taste of our people, find any considerable demand for consumption. The writer thinks, however, that leaf of this character can readily be made to resemble tea known as Oolong by a little less fermentation and increased firing. The former would leave it in such condition that when drawn the leaf would be green and the infusion light, and the latter would likely cure any tendency to raw or grassy flavor, and together make a tea that would look and taste like Oolong. The firing needs to be done with great care to avoid scorching the leaf, which, when drawn, gives the tea a burnt or malty flavor in the cup.

The same leaf entirely unfermented in all probability would, if thoroughly fired, make a tea resembling "natural leaf Japan," which is sufficiently popular to absorb the American production for years to come.

If leaf like the sample sent can be produced in quantity, we see no reason to doubt that tea can be made from it which will compete successfully with the Japan product, provided the cost can be brought within proper limits. The expense of manufacturing it as "natural leaf" must be reduced considerably by avoiding preparation for fermentation; hence it seems to us that the producers would do well to direct their further efforts to making an article of the kind last referred to rather than Oolong.

We think the sample submitted by Woodward and Barnwell can safely be valued at or more than 35 cents, but its sale would be quite limited. Thanking you for the privilege of tasting and viewing this specimen of American tea, we remain,

Very respectfully, yours,

BEEBE & BROTHER.

WILLIAM G. LE DUC, Esq.,
Commissioner of Agriculture.

NEW YORK, *May* 13, 1881.

DEAR SIR: The sample of tea sent you by Mr. Barnwell shows the same general characteristics of leaf and liquor as those grown and prepared by Mr. Jackson. He has made an error in this, however, that the tea should have been prepared either as a Congou or as an Oolong; as it is, it resembles neither thoroughly. In its present state, although most like a Congou or Assam Souchong, it still is not unlike an Oolong in many of its characteristics.

We should judge the leaf had not fermented long enough before firing, and the firing had been insufficient, also, to give to the leaf its best flavor.

In leaf it resembles the Oolongs from the Foochow district of China, and had it been fired green would, we think, have resembled them in liquor also.

We have again examined the samples you put before us of teas grown in the shade and those grown in the sun, and it is our opinion that sun-grown plants produce the strongest and most desirable leaf.

DEERFOOT FARM CENTRIFUGAL DAIRY.

By E. Lewis Sturtevant, M. D., *Waushakum Farm, South Framingham, Mass.*

Perhaps it is safe to say there is no farm in America which can present so much that is novel and useful to the observer as Deerfoot Farm, Southborough, Mass., the property of Mr. Edward Burnett. It is not amateur farming that is to be seen here, but real "fancy" farming, the use of intensive conditions, the employment of abundance of labor, and the availing practically of every new idea adapted to the conditions that promise improved profits.

This farm covers about 300 acres, of which some 100 are tillable. Its specialties are fancy pork, gilt-edged butter and cream, family milk, skim-milk, and buttermilk.

To meet these requirements much money has been expended for conveniences, and the farm partakes in its management of the character of a factory. The swine are grown on the place, or to order, are slaughtered as pig pork, and are presented for sale in small, neat, and attractive packages, which include "Deerfoot family pork," "Deerfoot hams," "Deerfoot bacon," "Deerfoot jowls," "Deerfoot pigs' feet," "Deerfoot sausages," "Deerfoot lard," &c. From the pens in the piggery, through the slaughter-room and packing-rooms to the market, there is the most precise cleanliness, and the wise use of all the advantages that well-constructed machinery, moved by steam power, can offer. In 1879 the number of pigs slaughtered was about 1,500, of an average weight of 175 pounds, the extreme weights of carcass being 140 and 250 pounds.

We, however, do not propose to describe this farm and this farming in detail, but to confine ourselves to the presentation of the dairy branch, which in like manner is worthy of attention from its development and from the novelty of its processes, for here are in use the only centrifugal milk machines, on other than an experimental scale, in America, and the skilled thought of the experimenter and the machinist have combined to produce the results best fitted for the handling, care, and manufacture of the milk.

The foundation idea which underlies this kind of farming is that there is a large discriminating public, who desire to purchase the best articles of the class, and who are willing to pay an increased price in order to secure perfection and uniformity of supply on their tables. Hence an expenditure may be justified in order to secure purity and cleanliness of product, attractiveness of packages, and such a sameness of quality that the brand stamped thereon shall justify confidence.

Milk is a very perishable commodity; it is quick to receive taints; it is readily influenced by surrounding conditions; it can only be retained in its best condition for a limited time through the exercise of the greatest care. It varies in character with the breed of cow, with the

individual cow to a less, yet still marked extent, and responds in its chemical and physical condition to changes within the cow. Its chemical composition shows it to be an emulsion of fat globules in a solution containing water, sugar of milk, casein, albumen, and salts. Its physical conformation is the fat globules which originate through the cell action within the ultimate follicles of the udder glands, and are formed by the proliferation and separation of, accompanied by a fatty change of contents in, the cells which line the interior of the milk glands. These fat globules are extremely minute, varying in size from the merest point to the comparatively large globule, measuring often $\frac{1}{2700}$ of an inch, exceptionally single globules as large as $\frac{1}{1500}$ of an inch in diameter. At one time in the history of their genesis they formed a portion of the cow, as cells, and hence it would be expected, as indeed observation has proven, that they partake in a certain degree of the changes which influence the cow. Hence a starvation of the cow, or any course which interferes with cell-growth in the animal, is perceived in the udder glands, through the diminution of the cell growth there, as evidenced by the deficiency of the completed fat globules in the milk. We also perceive that as various kinds of food influence growth development in the cow, *i. e.*, some foods have a greater fattening action than other foods, so change in the character of the food may be seen in the fat globule in the milk. Thus, the feeding of bran or shorts has a distinct influence in diminishing the size of the globule; the feeding a corn meal, a distinct effect in influencing uniformity of size in the fat globule. We also perceive an influence over the globule occasioned by the condition of the cow in relation to calving. When parturition has just taken place, and the colostrum condition of the milk exists, the globules are, many of them, aggregated, and show a great variation in size, and are often not free but attached to the membrane which has become disrupted through the intensity of the action accompanying the commencement of the milk flow. This colostrum has a putrefactive tendency. A little later the colostrum period has ceased, the flow of milk is abundant and normal, the shedding of the globules is complete, yet there is a striking disproportion in their size. The action connected with their growth is still irregular. As time increases the globules become more uniform in size, and there is a less disproportion between the largest and the smallest.

There is also to be recognized a difference in the globule accompanying the breed of the cow. In the Jersey breed the average size is larger than in the Ayrshire or Holstein breed; in the Ayrshire breed less uniformity of size, and more of the smaller globules, entitled granules, than in the Jersey or Holstein breed; in the Holstein breed, a small globule, quite a uniformity of size, and few granules.

It is interesting to note that this formation of the butter element of milk is a local one. It is governed by the structure and function of the gland which produces it, whether influenced through breed heredity or through local conditions. Oftentimes the milk from one teat of a cow will present globules in a different condition, and of different size than will the milk from one of the other teats. One teat will give colostrum while the other teats yield true milk. One teat will transmit a richer milk than will another teat. In general, so local is the formation of milk that I have never known the milk of the four teats to be identical in butter yield, in cream percentage, or in churning quality. This fact is indicated by the following analyses I had made of the milk from each teat of an Ayrshire cow, each sample being drawn alike under my own

immediate supervision, and the analyses made by a skilled chemist, S. P. Sharples.

Imported Ayrshire cow, Model of Perfection, No. 370, N. A. A. R., eleven years old; seven months from last calf. Feed: Pasture, fodder, corn, and six quarts of shorts.

Evening milk, August 6, 1876.

	Pounds.
1. Right forward teat, yield	2
2. Left forward teat, yield	1¼
3. Right rear teat, yield	1½
4. Left rear teat, yield	1¼

	No. 1.	No. 2.	No. 3.	No. 4.
Specific gravity	1.025	1.024	1.026	1.028
Cream, per cent	25	42	29	24
Sugar	4.09	2.18	3.44	4.20
Casein and albumen	4.48	6.58	5.00	5.59
Ash	.68	.61	.66	.67
Solids not fat	9.25	9.37	9.10	10.46
Fat	5.59	4.43	4.39	3.84
Total solids	14.84	13.80	13.49	14.30
Water	85.16	86.20	86.51	85.70
Total	100.00	100.00	100.00	100.00

The cream percentage in No. 2 is evidently fallacious. The cream, however, appeared natural, although thin, and read off with a distinct demarcation line from the skim milk.

On account of the importance of these facts, and in order to make sure that this was not an exceptional case, November 19, 1876, I had Mr. Sharples analyze the milk from the four teats of the Ayrshire heifer Tabitha, No. 487, N. A. A. R., two and a half years old, six months from last calving, stabled and fed on corn fodder, hay, and cob-meal.

	Pounds.
1. Right forward teat, yield	1⅜
2. Left forward teat, yield	1⅜
3. Right rear teat, yield	1¼
4. Left rear teat, yield	1⅜

	No. 1.	No. 2.	No. 3.	No. 4.
Specific gravity	1,032	1,031	1,030.6	1,031.5
Cream, per cent	14	11	13	10
Sugar	4.90	5.00	4.72	4.88
Casein and albumen	3.53	3.42	3.61	3.48
Ash	.59	.57	.61	.64
Solids not fat	9.02	8.99	8.94	9.00
Fat	3.32	3.00	2.73	2.13
Total solids	12.34	11.99	11.67	11.13
Water	87.66	88.01	88.33	88.87
Total	100.00	100.00	100.00	100.00

These globules have different churning reactions. The globule of the Jersey cow is more readily broken than is the corresponding sized globule from the Ayrshire cow, and is more readily acted upon by the changes resulting from the keeping of milk. The larger the globule, other things being equal, the quicker the churning, and the better the

quality of the butter in respect to the grain. Thus, of cream taken from milk at intervals of twelve hours, the first skimming, which contains the larger globules, produces butter of better quality than does the cream of the second skimming. The seeming explanation of this fact is the reasonable, although as yet unproven view, that the butter fats exist in a certain relation in the globules, and it is this natural relation which produces the so-called grain of butter; when this relation is disturbed by overworking the butter, this grain, so much desired, becomes lost. In the larger globules this arrangement is coarser and more distinct, as shown in the aggregate butter, than in the smaller globules. This view of the relations of the fats is, however, disputed by some, as it is claimed that in oleomargarine factories butter and tallow melted together and allowed to fall in a small stream into ice water takes on a condition which gives to the completed product a fine grain of high quality.

The fat globules again have a lower specific gravity than the fluid in which they float; they are invested in a membrane, probably animal in its origin, which is heavier than the fatty contents. Hence, as the different specific gravities of the envelope and the contents vary greatly as the diameters change, the large globules are specifically much lighter in relation to the fluid in which they float than are the smaller globules, and they accordingly rise with far greater rapidity towards the surface.

In addition, these form-elements of the milk have a different specific heat than the unformed fluid elements, and accordingly quick changes of temperature do not warm or cool the fat globules, and thus affect their specific gravity, in the same proportionate time as the fluid portion is warmed and cooled.

Millon and Commalle distinguish a casein suspended in milk, and another dissolved in it. This relation appears to have been generally overlooked by students on milk, yet I am disposed to believe that the microscope discovers many granules of this casein suspended in skim-milk, and these are often, perhaps, confounded with fat globules of such small size that their envelope loads them down so that their tendency is to remain in suspension or to fall rather than to rise. An analysis of the scum which collects upon the walls of the drum of the centrifugal machine, as analyzed by Lawrie and Terry, shows casein there at the point of greatest pressure to the amount of 25.49 per cent. As casein has a greater specific gravity than the other constituents of milk (1,280, according to Professor Goessman, in a private letter), all that casein which has form would naturally seek the circumference when put under the influence of centrifugal force. Moreover, if skim-milk be taken and diluted with a little water, the microscope will detect more granules in the lowermost layers, after it has stood quietly for some time, than in the upper portions. It is but proper to state, however, that analyses made for the purpose of this paper of the skim-milk from the interior and exterior of the milk as occupying the machine, not, however, including the outer layer where the scum accumulates, show a composition as nearly identical as can be expected, and no increase of casein, a fact which, while not opposed to this view, yet cannot be considered confirmatory.

The morphological relations of milk are those which concern us the most in our studies into the effect of centrifugal force upon this product of the cow, and hence the necessity of these preliminary observations bearing upon this form character. In this aspect the chemical relations are of less importance. We, however, would summarize briefly a few

facts that are conclusively established, and a few other circumstances which are as probably true.

There is no relation between the percentage of cream and percentage of butter that can be made therefrom. Hence, it is an absolute fact that the cream per cent. does not indicate the butter quantitative quality of the milk. The appearance of the cream does, however, afford us strong ground for a presumption that the denser the cream the more the butter that it will make. A cream percentage of 20 per cent., if by a constant series of jarrings it be reduced to 10 or 12 per cent., will make the same quantity of butter in its new form as in its old form.

The fat shown by analysis to exist in milk does not all appear as butter when the milk is churned. Churning is a physical process and acts upon the larger globules only. Hence, of two milks, showing like figures to analysis, the churn will separate more butter from one than the other, especially if the milks be from two distinct breeds of cows.

There exists in milk, under normal circumstances, a proportion of albumen varying from one-third to three-quarters per cent. There also exists an undetermined proportion of what may be called mucus, the wear and tear of the cow under the action of milk formation.

The casein of milk from different races has distinct properties. In human milk, when coagulated and dried, it possesses a friable character. In the milk of the bitch it does not become viscid and horny on drying. In cow's milk it becomes viscid and horny on drying. It also varies in character in the milks from different breeds of cows, being more horny on drying in the milk of the Jersey than in that of the Ayrshire breed. Rennet precipitates the coagulum with greater or less ease in different milks, as do also mineral acids.

The importance of alluding to these considerations will appear when we come to describe and discuss the practical relations of centrifugal force to the dairy.

DEERFOOT HERD.

The foundation of the milk industry is the cow, and hence we must commence by describing Mr. Burnett's cattle; and as the character of cattle are influenced by breeding, and as it is probable that the possession of the Jersey breed has had much influence in determining the direction towards the present outcome of Mr. Burnett's system, we must devote a few pages to his herd—the Deerfoot herd.

This herd was established by Dr. Joseph Burnett, in 1854, the animals coming from the Taintor importation, through Dr. Morton, of ether-discovery fame.

The object Dr. Burnett had in view was to secure richness of quality of milk and an abundant flow. To this end he carried his selections and his breeding. When the herd came into possession of Mr. Edward Burnett, in 1871, the same system was continued. No attention was or has been paid to solid colors or fancy points, but the whole desire was to obtain cows of large average size for the breed, long and rangy bodies, largely developed udders and escutcheons, and especially to secure udders of the Ayrshire type, but with large teats. The results that are now reached indicate clearly the wisdom of this course. There is now that uniformity in the herd which illustrates successful breeding. The colors are a dark gray; the size large for the breed; the head fine; the horns small and of Jersey texture and quality; the neck slim; the body long; the hips and flanks broad and deep; the carcass heavy in the rear, and giving an impression of lightness forward; the udder ca-

pacious, extending well forward, rather flat on the sole and well teated; the escutcheon marks well developed and well placed.

These cows mature early and continue their milk flow for a long time from calving. They are deep milkers, as the records which we present for the past seven years prove; indeed the quantity of milk is very large, and disproves the frequent assumption that the Jersey cow cannot be a large milker. The milk is of rich quality, the herd trials giving a range of one pound of butter to from seventeen to twenty-one pounds of milk, according to season, and other adventitious circumstances, under the ordinary methods of butter-making; and one pound of butter to from sixteen to twenty pounds of milk, with the centrifugal process of separating the cream. The butter is of high color and quality, and for many years has been of the "gilt-edged" type.

It is well to note that these are statements of herd trials, including all the cows in milk, and do not apply to the especial performance of any one cow.

Since 1873 a careful record has been kept of the milk yield of each cow in the herd, and I have taken these yields from Mr. Burnett's books, and the averages given below include every registered Jersey in milk during the year, and is rather below the real yield as including the young heifers, some of which calved towards the close of the year in which their first yield appears.

This course of figuring has something to do with the inequality of yields which appear in different years, but the character of the season and the times of calving, and other incidental circumstances, have also to be considered. For the purpose of comparison I append the yield of the Waushakum herd of Ayrshires for the same years, premising that as a general rule for these Ayreshires of mine, either no or but little grain has been fed, and no soiling crops have been grown.

Years.	Quarts per cow of Deerfoot herd (Jerseys).	Quarts per cow of Waushakum herd (Ayrshires).
1872	....	2,812
1873	2,050	2,528
1874	2,377	2,633
1875	2,215	1,901
1876	2,712	2,326
1877	2,475	2,466
1878	2,404	2,160
1879	2,726	1,903
Average for seven years	2,423	2,341

In explanation, we would say that the high price received for butter encouraged Mr. Burnett to increase his milk yield to the highest point, while the low price of milk encouraged me to obtain no more from the Ayrshires than they would give under the ordinary keeping of pasture in the summer, and hay and corn stover in winter. The value of these figures will be better apprehended when it is realized that the average yield of herds in the best dairy regions of New York is not in excess of 1,300 quarts per cow; the average yield of superior herds in the same region is not in excess of 1,800 quarts per cow; and the highest possible average yields of the best herds is not in excess of 2,300 quarts for the

best dairy regions. Whatever is more than this comes from the diffusion of thoroughbreds.

Nor will it be proper to assume that this herd yield applies generally to the Jersey breed. In the absence of figures to the contrary, we may say that it is so exceedingly exceptional that it has been brought about in this one case only, and this through most attentive care to breeding and the most rigorous series of selections.

While the Ayrshire results may be considered as of true breed significance, these Jersey results must be esteemed as of herd significance only. The Ayrshire cow is a large milker through race inheritance; the Jersey cow is a large milker only through individual inheritance, and Mr. Burnett's figures have the important significance of directing attention to what the art of man can accomplish and to the capabilities of a breed for dairy purposes.

The Jersey cow gives a milk peculiarly adapted for butter making, and usually, but not universally, rich. Thus Dr. Waller found the milk in one Jersey herd to vary from 2.92 per cent. of butter fat for one cow to 6.50 per cent. of butter fat for another. The Ayrshire cow presents like variations, but a milk not physically as well adapted to butter manipulation but better fitted for cheese.

These physical relations have an importance which the use of the centrifugal machine must ultimately bring into a recognized practical importance, as does even now the chemical constitution of milk receive recognition by the practical man.

There are some individual yields in the Deerfoot herd which are deserving of record. We present those of four cows of which we have the record for the longest time:

Years.	Pink 3d.	Pink 4th.	Susie.	Mab.
	Quarts.	*Quarts.*	*Quarts.*	*Quarts.*
1873	2,594	2,076	1,988	1,950
1874	3,118	2,566	2,298	2,463
1875	3,348	3,143	2,922	3,028
1876	3,922	3,879	3,476	3,384
1877	3,827	3,895	8,576	2,991
1878	3,660	2,820	3,495	2,978
1879	3,130	2,210	4,524	3,935
Average for seven years	3,371	2,941	3,182	2,933

We call attention to these figures, as they apply to the only Jersey herd, so far as we know, which has ventured to publish its figures as a herd, and they have indeed a public value.

The breeding of these four cows is shown by the following diagrams:

- **Pink 3d, 2766**
  - Jersey Boy, 272
    - Imp. Czar, 273.
    - Imp. Fanny, 675.
  - Imp. Pink, 676.

- **Pink 4th, 3985**
  - Jersey Boy, 272
    - Imp. Czar, 273.
    - Imp. Fanny, 675.
  - Imp. Pink, 676.

- **Mab, 3589**
  - Jersey Boy, 272
    - Imp. Czar, 273.
    - Imp. Fanny, 675.
  - Milly, 3588
    - Abe Lincoln, 268
      - Dick Sniveler, 34
        - Major, 75
          - Imp. Colonel, 76.
          - Imp. Countess, 114.
        - Imp. Flora, 113.
      - Diana, 692
        - Imp. Diamond, 155.
        - Imp. Flora, 43.
    - Duchess, 685
      - Imp. Czar, 273.
      - Imp. Fanny, 675.

- **Susie, 3982**
  - Jersey Boy, 272
    - Imp. Czar, 273.
    - Imp. Fanny, 635.
  - Snowdrop 2d, 3608
    - Imp. Czar, 273.
    - Imp. Snowdrop, 688.

We note that these cows are all sired by Jersey Boy, whose pedigree includes imported Czar and imported Fanny. That this milking quality is transmitted through the bulls, and is not accidental, is shown by the following table of yields, which includes all the animals in whose pedigree these names appear:

Daisy, 3,182	2,316 quarts in 1874.	(First premium New York, 1873.)
Deerfoot Maid	3,592 quarts in 1879.	("A master cow.")
Duchess, 685	2,777 quarts in 1874.	
Julia, 3510	3,593 quarts in 1876.	("A remarkable cow.")
Patty	2,728 quarts in 1879.	
Patty 2d, of Deerfoot	3,083 quarts in 1879.	
Princess, of Deerfoot	2,316 quarts in 1879.	
Princess, of Southborough	3,043 quarts in 1879.	

Mab's pedigree traces through Jersey Boy on the part of the sire, and on the dam's side is to be traced to Motley's celebrated imported animals, Colonel, Countess, and Flora, which now seem to be one of the gold-mine pedigrees of Jersey fanciers, and who are among the progenitors of "Jersey Belle of Scituate."

We think these figures are convincing as to the value of pedigree as a guide in breeding, and as such are deserving of all the study which they will receive.

CARE OF THE COWS.

The milking time is at 5 a. m. and 5 p. m., and the greatest regularity is sought. About eight or nine cows are considered sufficient for one milker. In summer the cattle are pastured, but driven to their stalls to be milked and to pass the night. They here receive some feed, and are consequently always quiet and easily herded. In the stable they are bedded on sand, according to the custom in this locality. They are carded regularly, not only for the sake of looks, but in order to secure that cleanliness which is such an essential condition in all that relates to the procuring and handling of milk. The stables are frequently whitewashed and no dirt or litter is allowed to remain.

THE FEEDING.

We shall here allow Mr. Burnett to speak for himself:

The essentials to produce the best results are good cows, good feed, regularity, cleanliness about the stables and dairy, and a thermometer. I will give you my own method of feeding and in so doing those dairymen who aim at *quantity* will realize that we are shooting at different targets, for with me quantity is secondary, quality being the greatest desideratum.

Our finest butter is obtained in early summer, when the pastures are sending forth their early, sweet, succulent grasses, and we depend entirely upon them; but when these begin to fail, about mid-summer, I begin to feed wilted clover and a small quantity of grain, increasing as the season advances, unless the pastures are unusually good. I cut all my grass early, beginning by the 5th of June, and generally get a good second crop, thus trying to have an abundance of rowen hay. When in winter quarters I begin feeding at about 5.30 in the morning with hay, a little jag or wisp at a time, not so much but what the cows will eat it up clean. Then, after milking, the grain—from three to six quarts, according to the cow—consisting of two parts of Indian meal and one of shorts or bran; or feeding entirely on ordinary cobbage (corn and cob ground together). After this, more hay, which lasts until about 9 a. m. I begin again at 3 p. m. with a little hay, followed by roots (mangolds) cut fine, a bushel being divided between three cows; then more hay again, which lasts them until about 6.30 p. m.

I maintain that if more shorts are fed than are necessary to counteract the heating quality and condensed richness of the corn meal, it deteriorates the butter. During last March, 1879, I saw this illustrated, being called upon in Boston to examine some butter from one of the finest dairies in the State, and which was troubling the dealer who sold it. He said it was negatively good; nothing could be said against it, yet mighty little could be said in its favor. It seemed to lack that fine nutty flavor so

necessary to fresh butter that commands over 40 cents per pound. I said at once, upon tasting it, "Too much shorts, and not enough corn meal." He answered, "Just what I thought, but didn't dare to say so until it was confirmed." In less than ten days the butter from that dairy was improved.

MANIPULATION.

There are two sources of supply for the milk, the home herd and that furnished by the neighboring farms. The milk of the morning and the evening is kept separated. The morning's milk from the home herd is poured from the milk cans into a large cooler, and is thence, after being cooled, bottled for market as new milk. In summer it is shipped at 7 p. m. The cooler which receives this portion is a large metal cylindrical vat (Fig. 1), of the capacity of 150 gallons. Within this is suspended a box containing ice, and attached to a lever, so that motion can be communicated to it in case the cooling is desired to be hastened, or a sort of propeller which keeps the milk in movement. As soon as the temperature is reduced to 50° the milk is drawn in successive portions into a pail (Fig. 2), and thence poured into the bottles (Fig. 3), which, after being corked securely, are transferred in the frames to the water refrigerator, as it may be called, where they remain until shipment.

We present in this place a plan of the dairy buildings, showing the various rooms, and the relative positions of the fixtures which are in use, while separate illustrations, where required, give a full idea and instruction of the system followed. The milk tank (Fig. 1), with its cooler which receives the milk from the upper floor, is suspended at a convenient height on the elevator, and by means of a faucet delivers the milk into the pail (Fig. 2) which is used to fill the bottles, (Fig. 3). The bottles are handled in wire frames which hold twenty, and these frames are transferred to the water-refrigerator (Fig. 4), where they rest on a wire grating, *b b*, which is raised and lowered by means of machinery, thus conveniently lowering the filled and tightly-corked bottles under the ice water, and raising them again to the surface for handling.

These bottles are of the Cohansey pattern, and are of the capacity of one quart. The cover is secured by wire clamps, which, by compressing against an intervening rubber, form a tight joint. These bottles are delivered to the customer each morning, and at the same time the empty ones are returned to the farm, where, after a thorough cleansing, they are again filled for use.

The upper story, which is on a level with the ground in the rear, is also shown in the plan. Under a shed is the delivery, as indicated, each can of milk being weighed at the scales, and the weights charged off. The cans are then moved into the delivery room *x*, and the milk is emptied into the tank *m*, within the refrigerator room *y*, thence to pass by a pipe into the centrifugal machine below, or is poured into the tank (Fig. 1) for fresh-milk delivery, as described. The empty cans (Fig. 5), after being cleansed over the steam jets *h* in the shed, are stored in delivery room until again put into requisition.

The cans used are of the capacity of 20, 30, and 40 quarts, and have large covers, which spring into place, and strong handles. One is shown in section in the illustration (Fig. 5).

The next room is the wash room *w*. The tanks *i i* are furnished with cold water through faucets, and also with steam pipes, through which steam is admitted to the water in the tanks to warm it. Movable draining trays, or slatted tables on casters, receive the bottles after the cleansing in the hot-water tanks. Into this room opens the stairs from

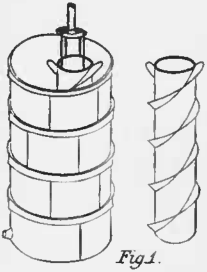


Fig.1.

Fig.2.

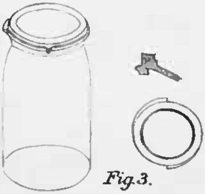


Fig.3.

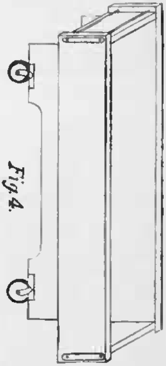


Fig.4.

DEERFOOT FARM CENTRIFUGAL DAIRY.—*Machinery.*

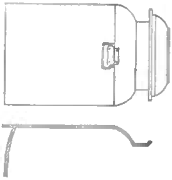
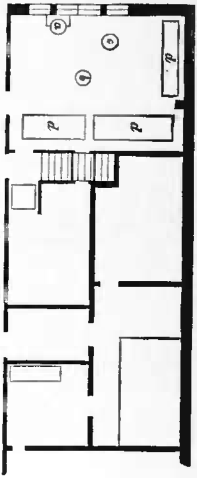
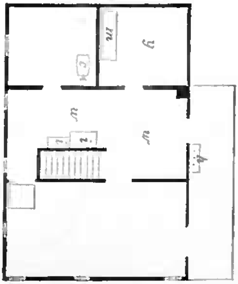
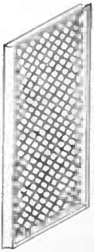


Fig 5.







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Deerfoot Farm Centrifugal Dairy.—*Plan, Machinery, &c.*

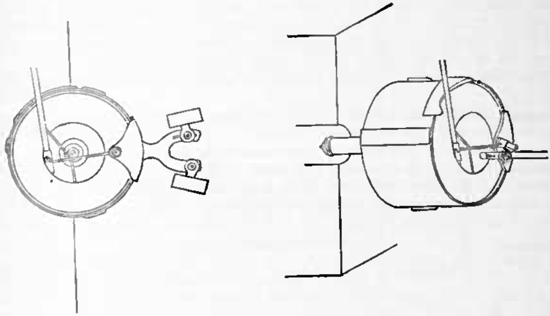


Fig. 7.

DEERFOOT FARM CENTRIFUGAL DAIRY.—*Machinery.*

the lower floor; and other doors lead to the storage refrigerator, and the churning-refrigerator room.

In the storage-refrigerator room *y* are kept the cream, the butter awaiting delivery, and the milk in the tank *m* which supplies the centrifugal machines below.

In the churning refrigerator the cream is churned by power in a barrel churn, *c*, and the butter is worked and pressed into form for the market.

Passing into the centrifugal room on the lower floor, we find three centrifugal machines, *a*, *b*, and *c*, over each of which is a pipe connecting with the milk tank in the refrigerator room overhead, and three tanks, *d*, in the floor, which receive the skim-milk in cans, and where the cans remain until shipped. In these tanks of water a block of ice is kept floating.

Two styles of centrifugal machines are in use—one a self-delivery, the others intermittent deliveries. We shall describe the first as machine No. 1, Fig. 6,* and the second as machine No. 2, Fig. 7.

The machines being put into motion, the faucet of the pipe connecting with the milk tank *m* is opened, and each machine receives its charge. After running about fifteen minutes the cream has collected on the interior wall of the milk, and then in No. 1 the faucet is again turned, and the admitted milk displaces a thin stratum of cream, which is collected in the manner shown by the diagram. At the same time the skim-milk escapes through small valvular openings in the bottom. In this illustration will be seen a small cup, *h*, which occupies the axis, and from which a pipe, *e*, extends towards the circumference. This receives the milk as it falls from the pipe *d*, and conveys it toward the circumference, and away from the cream wall. The metal pan *c*, which covers the outgoing cream, is also shown.

Collected in this apparatus the milk is carried to the pipe or outflow, *f*, as shown. The skim-milk, passing into the surrounding frame *g*, as shown, is likewise conveyed, by a pipe, *e*, into the receptacle placed to receive it.

Machine No. 2 is of a different construction. After the cream has collected to form the interior wall, a pipe scoop, *e*, is brought into contact with the revolving surface, and the cream is forced along the pipe and conveyed to a pail placed near for its reception. After the cream is removed, a like quantity of milk is added from the faucet *h*, and this displaces the cream which has escaped removal on account of its position, to the point where the scoop works. In a few moments the cream is thrown off through the scoop pipe *e*, and then the skim-milk is removed in the same way, when a new charge of milk is admitted. This process takes place about three times an hour.

The pails of cream are now removed to the refrigerator room, upper floor, while the cans of skim-milk are transferred to the ice-water tanks *d* in the lower floor. In one experiment, watched by myself, so as to secure the ordinary conditions, 172 pounds of milk, in machine No. 2, yielded 21 pounds of cream such as is bottled for market, or 12 per cent. by weight.

Machine No. 3 is similar, except being slightly larger than machine No. 2, and requires no separate description.

On account of the novelty of this system, it seems well to devote some space to theoretical and practical considerations upon this method of dairying, and in the proper place to consider the advantages which are claimed, and such as may be admitted to belong to it. From the nature of the material in use—milk—and from the character of the forces employed, it must happen that the observations of different reporters must

* The drawings of this machine were lost.

vary according as there is variation in the milk, in the forms of the machines in use, and the speed at which they move. This we will proceed to do before we pass to the utilizing of cream for butter.

THEORETICAL AND PRACTICAL OBSERVATIONS—CENTRIFUGAL CREAM RAISING.

The value of this process in saving more of the butter from milk than the ordinary methods of setting milk has not been systematically shown by Mr. Burnett, although a few experiments indicate a gain, which will be figured further on. In an excellent summary of European experiments by Dr. T. R. Englehardt, he offers the results of European determinations between the centrifugal raised cream, and that obtained by the ice and Holstein method. Two hundred pounds of milk were used for each experiment, and the correctness of the obtained results were verified by chemical analyses of the butter, buttermilk, and skim-milk obtained in the operation. The vessels for the ice method held 50 pounds of milk each, and were filled to the depth of 16 inches; time employed, 34 hours. The centrifugal used was the Lefeldt machine, running 1,040 revolutions per minute, except from August 8 to September 2, when its motion was irregular, and after this date was reduced to 950 revolutions per minute. At the higher speed 31 minutes, at the lower speed 36½ minutes, were occupied in the gaining of the cream.

Pounds of milk per one pound of butter.

Date.	Centrifugal.	Ice, 38 hours.	Holstein method.
1879—May	27.6	30.0	30.4
June	26.4	28.3	28.8
July	26.8	28.0	30.5
August 1 and September 2	28.5	27.7	31.7
September 3 to	26.6	27.6	30.9
October	24.3	28.7	27.9
November	24.6	31.5	28.4
December	24.2	28.5	27.4
1880—January	25.8	27.8	28.0
February	26.4	27.4	27.8
March	27.8	28.8	29.5
April	29.3	28.4	30.1
Average	26.5	28.5	29.2

The gain of the centrifugal process over these other methods is shown by the annexed table:

Date.	Proportional results between—		
	Centrifugal.	Ice, 34 hours.	Holstein method.
1879—May	100	92.3	90.6
June	100	93.2	91.2
July	100	85.7	87.9
August 1 and September 2	100	103.2	90.1
September 3 to	100	96.4	86.2
October	100	84.7	87.0
November	100	78.1	86.5
December	100	84.9	88.4
1880—January	100	72.9	96.9
February	100	96.3	94.9
March	100	96.4	94.3
April	100	96.1	94.0
Average	100	91.7	93.2

Neither these percentages nor the butter yield indicate a milk of such good quality as is used in America, for the best result here indicated is, for the year, 26.5 pounds of milk to 1 pound of butter, while under the system of setting in vogue in factories in America it is 23.18 pounds of milk for 1 of butter, thus:

Years.	No. of factories reporting.	Average pounds of milk to 1 pound of butter.	Extremes.
1871	6	23.05	22.54 and 25.16
1872	4	22.88	22.3 and 24.26
1873	6	23.5	22.36 and 24.4

The difference between the centrifugal and other methods in our tables is in favor of the centrifugal 8.7 per cent. and 10.9 per cent., respectively, or about the same as Mr. Burnett has found, for his few trials have given—

	Pounds of milk to 1 pound of butter.
For the centrifugal	16 to 20
For the deep-can setting	17 to 21

That is, on the mean of these figures, each 100 pounds of milk in the centrifugal process yielded 5.55 pounds of butter; in the deep-can process, 5.26 pounds of butter—a difference of 0.29 pounds in favor of the centrifugal, or 8.1 per cent.

In the buttermilk from 100 pounds fresh milk, in these foreign experiments, were found of fat: in that of the centrifugal, 0.07; in that of the ice method, 0.06 per cent. of fat, and in that of the Holstein method 0.07, thus *indicating* a churning quality in the order given. The skim-milk analyzed for fat gave—

	Average.	Extremes.
		Per cent. fat.
For the centrifugal	0.35	0.25 to 0.44
For the ice method	0.62	0.34 to 1.54
For the Holstein method	0.68	0.40 to 1.03

Some interesting experiments made in Austria by J. A. Von Tschawel and Dr. Engling, with an improved Lefeldt machine, gave the following results to analysis:

COMPOSITION.

80 minutes in centrifugal.

Constituents.	Milk.	Skim-milk.
Water	88.11	91.61
Fat	4.12	0.37
Casein	2.80	2.76
Albumen	0.34	0.41
Sugar	3.85	4.11
Ash	0.78	0.72
70 minutes in centrifugal.		
Water	88.73	91.65
Fat	3.82	0.31
Casein	2.64	2.62
Albumen	0.42	0.46
Sugar	3.66	4.05
Ash	0.73	0.71

An analysis made of the milk and skim-milk used in Mr. Burnett's centrifugal in the winter of 1879, by Lawrie and Terry, is as below, the time in the machine about 15 or 20 minutes.

Constituents.	Milk.	Skim-milk.
Water	85.58	89.68
Fat	4.42	0.90
Casein and albumen	4.41	4.24
Sugar	4.88	4.44
Ash	0.71	0.74

Another analysis, this last by S. P. Sharples, October 22, 1880, of the milk of the preceding day, gave:

Constituents.	Milk.	Skim-milk.
Water	87.94	90.47
Fat	2.23	0.07
Casein, &c	4.24	4.03
Sugar	4.85	4.70
Ash	0.74	0.77

The specific gravity of the cream at about this time, as prepared for market, was determined by me as 1,014. A sample taken from the machine, ran purposely for a considerably longer time, gave a specific gravity of 962; more recent results give even less, 956.4, the cream being longer under the influence of the machine.

It is of interest to note that all the heavier impurities in milk, under the influence of the centrifugal force, seek the circumference. Here collects, after a time, a slimy layer, greenish in color, largely miscible in water, and extremely offensive. The microscope develops granules, epithelial cells, and various constituents of dust. A sample analyzed by Lawrie and Terry gave:

Water	67.38
Fat	3.25
Casein, &c	25.49
Ash	3.88

October 21, 1880, I was on hand early in the morning, and superintended an experiment with the larger machine, No. 2. The process was carried on by the man in charge in the usual course, except that the machine was run from 7.45 a. m. to 8.25 a. m. before the cream was commenced to be removed, a rather longer time than usual, or forty minutes. The last of the skim-milk was removed by 8.42 a. m., this intervening time being caused by the addition of a quantity of skim-milk after the removal of the cream by the pipe-scoop *e*, after each successive withdrawal of cream, in order to bring the cream surface over the horizontal diaphragm *d d*, which is indicated in Fig. 7, and which has no obvious object or use as connected with the theory or working. The analysis of the milk, as collected in a bottle from the pipe leading into the machine from the delivery tank, was found by S. P. Sharples to be:

Specific gravity	1,033
Water	87.94
Casein, &c	4.24
Sugar	4.85
Fat	2.23
Ash	0.74
	100.00

This indicates a milk of rather low quality, but it applies to the milk as brought in by the farmers from stock fed probably on corn stover and frosted pasturage, and perhaps to be considered as from short-horn and Ayrshire grades, with, say, 10 per cent. of Jersey blood.

In forty minutes from the starting of the machine, an 8-ounce bottle of cream was taken for analysis, and it yielded the following result:

Specific gravity	956.4
Water	49.45
Fat	43.14
Casein, &c	3.31
Sugar	3.70
Ash	0.40
	100.00

It may be interesting to compare this analysis with others:

Kinds of cream.	Water.	Fat.	Casein, &c.	Sugar.	Ash.	Authority.
Mixed cream	59.25	35.00	2.20	3.05	0.50	Muller.
Country cream	49.00	42.00	4.20	3.80	0.60	Perry.
Jersey cream	36.40	56.80	3.80	2.80	0.20	Do.
Cream	74.46	18.18	2.69	4.08	0.59	Voelcker.
Centrifugal cream	29.54	67.63	1.17	1.42	0.12	London Farmer.

As soon as the cream was all removed, I took samples of skim-milk from the layer just below the cream, and from the outermost layer. The analyses were as below:

Constituents.	Inner sample.	Outer sample.
Water	90.44	90.50
Fat	0.05	0.10
Casein, &c	4.13	3.83
Sugar	4.60	4.80
Ash	0.78	0.77
	100.00	100.00
Specific gravity	1,035	1,035

A sample of buttermilk analyzed:

Specific gravity	1,035
Water	88.96
Fat	1.41
Casein, &c	4.47
Sugar	4.25
Ash	0.91
	100.00

These samples were all tested for albumen. There was none found by Mr. Sharples in the ordinary form as precipitated by heat or acids from the whey, but an undetermined amount of lacto-proteins was found to exist in them all. We place, for comparison, the specific gravities as obtained:

The milk	1,033
The cream	956.4
Skim-milk	1,035
Buttermilk	1,035

In order to comprehend these results it is necessary to discuss the theory of the force.

CENTRIFUGAL FORCE.

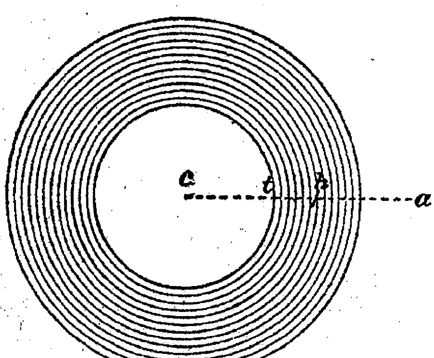
Centrifugal force is that force which tends to make a body fly from the center around which it revolves. The law of this force is that it *increases according to the square of its velocity.* That is, if the mass is caused to double its rotations about an axis in a given time, the force exerted pulling from the axis will be four times as great. The acceleration due to a centrifugal force is equal to *the square of the velocity divided by the radius.* Thus, if a ball weighing 10 pounds is whirled around in a circle whose radius is 10 feet, with a velocity of 30 feet per second, the acceleration of the centrifugal force is 90 feet; and since the pressures produced by two forces are proportioned to their accelerations, the tension on the cord restraining the ball is nearly 28 pounds.

The sum of the principles applying to our case is, that in the case of a body whirled around a center and restrained by a string, the tension of the string will be measured by the centrifugal force. The radius remaining constant, the tension will increase as the square of the velocity.

In the centrifugal milk machine, we have, let us assume, a circular basin 2 feet in diameter and 10 inches deep, containing 100 pounds of milk, and revolving at the rate of 1,000 times per minute. What is the pressure per square inch on the periphery? The area of the periphery is about 750 inches. The velocity of any given point on the periphery is 6,283 feet a minute, or 104 feet a second.

Let us first look at this case as if a 100 pound weight were attached to the axis at 1 foot distance. According to the rule given above, the acceleration due to the centrifugal force is $\frac{v^2}{r}$ or $\frac{104^2}{1}=10{,}816$ feet; and since pressures produced by two forces are proportional to their accelerations, we have:—100 pounds: t. (the tension):: $\frac{g}{1}$ (the acceleration due to gravity per second, 32.2 feet): 10.816 (the acceleration due to the centrifugal force). Therefore $T=\frac{1081600}{32.2}=33{,}590$ pounds. As this tension is distributed throughout the peripheral area, we must divide by 750 in order to get the values in square inches. Doing this, we have for the calculated pressure against the circumference about 44 pounds per square inch.

In calculating the pressure, however, for a fluid distributed as it is distributed in the centrifugal machine, we must figure the working radius to be the distance of the center of gravity from the axis; or the radius of gyration, as it is called, must be considered, instead of the radius of revolution. Thus, in a revolving ring of homogenous quality, *c a* is the radius of the machine, *c h* the radius of gyration. To establish this point *h*, we have for a rule:—add the square of the inner radius *c t* to the square of the outer radius *c a*. Divide their sum by 2. Take the square root of the quotient.



Mr. Burnett's machine, No. 1, is 18 inches in diameter, with a 7-inch opening, and 12 inches deep. It has a working capacity of about 100 pounds of milk. Machine No. 2 is 2 feet in diameter, an opening of 12½ inches, and a depth of 14 inches at circumference. The working capacity is 172 pounds of milk. The

ordinary number of revolutions while at work is 2,000 per minute for No. 1 and 1,600 for No. 2.

We have, from our above statements, the following dates for these machines as running:

	No. 1, Fig. 6.	No. 2, Fig. 7.
Radius *c a* .... inches..	9	9
Radius *c t* .... do....	$3\frac{1}{4}$	$6\frac{1}{2}$
Thickness of ring of milk .... do....	$5\frac{3}{4}$	$5\frac{1}{2}$
Radius of gyration, *c h* .... do....	6.8	9.6
Circumference of circle of gyration .... do....	42.8	59.6
Peripheral area at circle of gyration .... square inches..	513	834
Peripheral area at circumference .... do....	678	1,055
Movement per second at circle of gyration .... feet..	119	132
Acceleration due to gravity per second .... do....	32.2	32.2
Acceleration due to centrifugal force per second .... do....	25,019	21,780
Weight of milk .... pounds..	100	172

According to the formula for tensions, we have—$w : t :: g : c.$, $t = \frac{w\,c}{g}$; w representing weight, t. tension; c, acceleration due to centrifugal force; g, acceleration due to gravity. Substituting the values we have obtained: $T = \frac{100 \times 25019}{32.2} = 77698$. Dividing by area, we have $\frac{77698}{513} = 151$ pounds per square inch for the average pressure exerted on the milk, and $\frac{77698}{678} = 114$ pounds pressure exerted by the milk per square inch against the periphery for machine No 1 at 2,000 revolutions per minute. $T = \frac{172 + 21780}{32.2} = 116340$. Dividing by area we have $\frac{116340}{834} = 139$ pounds per square inch for the average pressure exerted on the milk, and $\frac{116340}{1055} = 110$ pounds for the pressure per square inch against the periphery of machine No. 2 running at 1,600 revolutions per minute.

We are particular in giving the forms for calculation, as the amount of pressure at a given time is of importance in the consideration of the results which are obtained from centrifugal machines, and this data will avail to enable calculations to be readily made for circumstances of difference of diameter, difference of weights of milk per square inch of depth, and differences of speed.

The capacities of these machines are about 500 to 700 pounds of milk a working hour. The milk, stored in a vat, *m*, upon the upper floor, is carried first through a steam jacket, which warms it to a temperature of 90° Fahr., and thence is allowed to pass into the centrifugal, which is revolving at speed. Here, coming under the influence of centrifugal force, it is at once heaped up against the circumference, and this continues until the machine is filled to the point of the opening: Under this tension, all the heavier portions of the milk are forced towards the periphery, and a wall of the lighter cream gradually forms on the interior of the circle. As soon as the cream is sufficiently separated, say in from fifteen to twenty minutes, in machine No. 1, it is displaced over the edge by the admission of a stream of fresh milk, and in machine No. 2 is removed by gradually bringing the pipe-scoop *e*, as shown in the illustration, into surface contact with the cream.

It will be thus seen that in machine No. 1 the delivery of cream into one receptacle, and of the skim-milk in another vessel, is a continuous

process, proportional in quantities to the percentages of cream and skim-milk removed; in machine No. 2 an intermittent process, the cream being periodcally removed according to the judgment of the operator.

This cream is of different densities according to the speed of revolution under which it is procured, and according to the time during which it remains under the influence of the machine. Its density and its qualities are also affected by the temperature of the milk, as well as by the character of the milk. The cream which is just removed is of a better quality than that which comes last, because, as our preliminary remarks on the fat globule shows, the larger globules are those which, being specifically the lighter, are first collected, and hence occupy mostly the interior layer. At present it is a matter of observation that the best results are obtainable with milk just from the cow; milk which has stood until some of the cream has come to the surface gives not as good results. Under circumstances of equal time, and the same number of rotations, the cream is obtained of a greater density from the machine of the larger diameter.

In machine No. 2 the cream is removed by the pipe-scoop from the upper inner layer; then a fresh charge of milk equal in bulk to the cream removed is added; and this is done several times, until the cream is all extracted. The skim-milk is then run through the scoop into cans, and a charge of new milk is again added. About 516 pounds of milk is thus used per hour in practice.

At 3½ inches from the axis, in machine No. 1, the velocity is about 60 feet per second, or at about the speed of a railroad train going 40 miles an hour. The cream, which is forced over the opening through displacement, is but a thin strata, and, possessing but little momentum, is not injured by the shock of impact, in collection, as is shown through a microscopic examination. It appears with but little foam.

In machine No. 2, the pipe-scoop acts against a surface revolving at a speed of from 90 to 167 feet per second as it works from the interior of the circle outwards. The cream removed contains, hence, more foam than does the cream from machine No. 1, and the skim-milk, especially that drawn last, is a foamy mass, occupying in practice nearly twice the bulk of the original quantity. Thus four cans are required to draw the contents of two original cans of milk placed in the machine, if no time be allowed for the foam to settle. The amount of this foaming is also regulated somewhat by the temperature.

January 9, 1880, a careful examination of the cream from machine No. 1, showed under the microscope an extreme purity, and no ruptured or disturbed globules. October 23, 1880, a similar examination of cream from machine No. 2 showed the same purity, but many of the globules were disturbed, and some were bulged. The sizes were quite uniform in both cases, and samples for examination taken from different strata showed marked changes in size of globule.

CREAM DISPOSAL.

The cream in the refrigerator room finds two outlets for market. A portion, depending upon the demand, is taken to the bottling room, and sealed in quart bottles, for delivery to customers as fresh cream. The balance is transferred to the churn in the adjoining refrigerator room.

The cream after standing twenty hours is churned in a barrel churn, moved by power, at a temperature of 60°, and the process usually occupies about twenty-five minutes; about 12 gallons of cream at one time, which yields about 70 pounds of butter. After the butter is gathered

in the churn, it is washed three times with pickle, and removed to the butter-worker, where it is freed from buttermilk, and salted, 4 ounces of salt being used to 10 pounds of butter.

The butter-worker used is the one known as the Vermont Machine Company's butter-worker. The roller compresses the butter into a thin layer, and the moisture is sopped up with a moist sponge pressed against the butter. After being sufficiently worked in the judgment of the operator, it is formed by wooden pads into a block, and removed to a table preparatory to being weighed out into half-pound parcels, and pressed into shape. Much depends upon the working; to gain high-class butter this process must not be continued too long, as the tendency is to destroy the grain and make the butter salvy; nor yet must it be shirked. The buttermilk requires to be worked out, and only the water of combination, so to call it, left behind.

Good butter wants to appear dry when cut; no water must be seen bedewing the surface cut by the knife, and yet it is probable that the best-quality butters contain the largest quanity of water. In this respect, *other things being equal*, the quantity of water shown by analysis grades the butter examined into its respective qualities; but, unfortunately, other things are not equal, and analysis does not represent the taste and texture upon which the quality depends.

In October, 1876, a sample of Mr. Burnett's butter, made from cream raised in the ordinary way, yielded to analysis, to S. P. Sharples:

	Per cent.
Fat	86.01
Water	11.15
Casein, &c	1.77
Ash	1.07

This butter was high-colored, hard, firm, full-grained, and apparently dry, notwithstanding the 11.15 per cent. of water shown in the analysis.

October 28, 1880, analysis, also by S. P. Sharples, the centrifugal cream butter, gave, no salt having been added:

	Per cent.
Fat	84.53
Water	14.27
Casein, &c	1.11
Ash	0.09

This butter was high-colored, firm, rather soft-grained, and apparently dry, of excellent quality, however, the principal defect being the lack of grain.

In November, 1876, Mr. Sharples analyzed for me several samples of butter gathered from the dealers.

	Retail price, per pound.	Water.	Fat.	Casein, &c.	Ash.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
No. 1	$0 90	11.15	86.01	1.77	1.07
No. 2	80	9.44	87.78	2.02	0.76
No. 3	75	9.94	85.89	2.68	1.49
No. 4	40	9.52	86.95	1.65	1.88
No. 5	25	9.88	87.14	1.90	1.08
No. 6, centrifugal, 1880		14.27	84.53	1.11	0.09

Nos. 1, 2, and 3, Jersey butter; No. 4, largely if not entirely Jersey; No. 5, sample of tub butter of rather poor quality. This No. 5 had drops of water over its cut surfaces, while the other butters appeared dry. No.

6, the centrifugal of recent make, containing more water, less fat, less casein, and less ash than any.

It is evident that if much water in butter is no disadvantage to the quality, and is satisfactory to the consumer, that that dairyman whose butter, other things being equal, contains the most water is gaining an advantage, and an advantage of considerable importance.

The butter is pressed by a machine into blocks, and stamped with a monogram which marks the half-pound lump into two portions, so that the consumer can, by dividing, have neatly-formed pats of a size proper for the table without injury to the appearance of the stamp.

Wherever extra price is obtained, much attention must be given to the attractiveness of packages, and this plan has been found not only satisfactory to the consumer, but to remunerate as well the slight extra expense which follows its use. These pats, each wrapped in a small piece of wet linen and stowed into tin boxes of slight depth, are thus sent to market.

SYSTEM.

The system adopted is to make each employé responsible for certain well-defined duties. Upon entering the dairy room, a framed placard is to be seen, thus:

DEERFOOT FARM, SOUTHBOROUGH, MASS.

DAIRY DEPARTMENT, OCTOBER, 1880.

Basement.—Mr. M———, responsible for machines, shafting, tanks. Also entry, stairs, &c.

Milk room.—A. O'C———, responsible for tank, windows, elevator, &c.

Upper floor, piazza.—C. R———, responsible for cans, milk pails, sinks, racks, windows, scales, brass, &c.

Refrigerators.—J. E. M———, responsible for churn, shafting, cream pails, butter, utensils, &c.

J. E. M———, *Foreman.*
W. E. BURKE,
General Manager.

This placard indicates what in handling milk must never be overlooked, the necessity of absolute cleanliness, and the most scrupulous care exercised to prevent offensiveness in any form. In this respect Deerfoot Farm is indeed a model. The amount of water used is enormous. Hot steam is in constant requisition for scalding almost every surface, and rubber wraps and scrubbing cloths are in use almost continually.

The men employed are dressed in white overalls, and sacks and aprons. The tin is everywhere bright; wherever brass appears it is in full polish; the air is sweet and no foul odors anywhere; and this is the case not only within the dairy buildings and the cow stables, but everywhere around them.

One man is employed on the machines in the centrifugal rooms; he also cares for the skim-milk. Another man cares for the bottling, which includes the washing of the bottles and other minor duties. A third man has charge of the butter manufacture. Over all is the skillful and exact supervision of the general manager, and behind him the proprietor.

A steam engine of 10-horse power furnishes the force required in both the dairy and the pork department, and this requires an engineer, who is also his own fireman. The large boiler furnishes steam from 80 to 90 pounds pressure, for all wants, and the surroundings here are all

in perfect neatness and even brilliancy. By means of shafting the power is carried to the centrifugal machines, the churn, and the elevator. Other shafts connect with the pork room to move the machinery there, while still other lines of shaft move the pumps which elevate the water used, the grindstones, &c. From the boiler the steam is carried wherever it is wanted to be used in cleansing utensils or surfaces, for heating water, for trying out lard, for cooking pigs' feet, &c.

HISTORY.

The history of the use of centrifugal force as applied to cream raising is briefly as follows:

In 1859, Prof. C. F. Fuchs, of Carlsbad, proposed to employ centrifugal force to prove the amount of cream in milk.

In 1864, Mr. Brandtl, a Munich brewer, applied centrifugal force to the separation of cream from milk on a large scale, but we know of no figures of his results having been published.

In 1868, D. M. Weston, of Boston, patented the machine in use at Deerfoot Farm. He has built experimentally many forms, and is yet interested in their improvement, some recent patent claims having just been allowed.

In 1874, Lefeldt & Leutsch, engineers of Schoeningen, Germany, exhibited their patented machines at the International Dairy Fair at Bremen, and these machines are claimed to have been the first practical ones in use. These parties took out American patents in September, 1877, and again in August, 1879.

In 1878, Rev. H. F. Bond, of Northborough, Mass., commenced experiments in this direction, ignorant that any had preceded him. Two quart glass fruit-jars were hung on the extremities of bars 2 feet long, which were made to rotate horizontally about 200 revolutions per minute, and filled with milk two or three hours from the cow. In one hour the cream was separated completely, being of a leathery appearance and crinkling when disturbed. A few weeks later a little tin tub or basket about 10 inches in diameter was used and caused to rotate about 1,500 times a minute, and to this valves were attached that could be opened, while the machine was in rotation, for the purpose of discharging the skim-milk.

I have now [says Mr. Bond] a neat little machine made similarly, within a few months, for determining with great accuracy the butter quality of a cow. I have also a machine made lately for using glass test tubes centrifugally. The tubes are prevented from breaking by setting them into metallic buckets and surrounding them with water, the pressure of the water on the outside counteracting the pressure of the milk on the inside. Mr. Martin Griffin, milk-inspector, 30 Pemberton square, Boston, has one.

In 1879, De Laval, of Sweden, exhibited his machine at the Royal Agricultural Society's show at Kilburn, England. This is a self-delivery machine, of small diameter, which runs at a high speed. It attracted much attention.

At the International Dairy Fair at New York, in 1879, a machine was shown in operation by M. I. Krebs, of Denmark.

At the present time we know of no machine being offered for sale in this country, and we cannot name their cost or price.

The De Laval machine in England was priced at £28 for the 11-inch machine. The Lefeldt machine is priced, so we are informed, at even less.

CLAIMS.

The claims for the centrifugal process are:

1. It will do away with the bother and expense of setting milk in pans for cream raising.
2. It will necessitate the use of less capital in the erection of dairy houses and fittings.
3. The cream can be separated from the milk as soon as withdrawn from the cow, and the cream churned immediately.
4. It opens up a new business in supplying fresh cream to consumers, who will not be slow in discovering its merits.
5. It will admit of the manufacture of sweet skim-milk cheese.
6. It offers economy in disposing of all the products of milk, fresh cream, fresh skim-milk, sweet buttermilk.
7. A more complete separation of the cream from milk than can be obtained by the ordinary process.
8. It admits of the quick and ready disposal of surplus milk left over on the hands of milk contractors, and thus is of assistance in diminishing the waste inseparable from the handling of milk, and bringing it before the consumer.
9. It purifies the milk completely by throwing out the slime and all extraneous matter.

The claims which, from present experience at Deerfoot Farm, may be reasonably allowed, are:

1. Purity of product.
2. A larger yield of butter than by the ordinary system.
3. A fresh skim-milk, and hence in a better condition to market.
4. Diminished waste in the handling.
5. A quality of cream which is unsurpassed for table use.
6. It is proved, however, that the cream gives better butter results after being kept some time than when churned fresh, and hence the advantage of fresh buttermilk is not realized.
7. A probable economy in the fixtures required and in the expense of handling.

It has been observed in foreign experiments that the skim-milk makes not as good quality cheese as ordinary skim-milk. This is in part from the absence of fat in it, and in part from conditions which as seem yet obscure.

OUR CONVICTION.

It seems to us that the use of the centrifugal machine will ultimately revolutionize the milk interest, although, as yet, its use must be deemed experimental only. In time manufacturers will realize what the dairyman requires in a machine, and inventive genius will seek its reward in this direction. It will be seen that the conditions required for a farmer's dairy centrifugal are different from those required for the factory where much milk is handled and where abundance of power is at hand. A machine at low cost, one that can be revolved at a sufficiently high speed, by such a power as a farm can support, will tend to make easier the care of the milk and enlarge the profits. A dairy of twenty cows would save enough yearly in extra butter produced to pay for a machine.

In our opinion, the farm machine must belong to the self-delivery class, be one in which the milk can be passed in a steady stream, and which will separate the milk into cream in one pail and skim-milk in another. It must be simple in construction and efficient in action. The

time occupied, if not unreasonably long, is of little consequence as compared to the economy of construction and running, and to efficiency.

The dairy machine may be larger and more complicated, if necessary to secure greater efficiency, and may be intermittent or permanent in delivery, as may be found most desirable.

The use of centrifugal machines for cream-raising will also, in our opinion, call attention to the differences between milks, and will thus tend toward an increased attention to securing uniformity of milk by the use of milk from distinct breeds of cows. From a theoretical and experimental position it may be prophesied with considerable certainty that the best results will occur where large-globuled milks are used, and where the feed is of a nutritious and succulent character.

It is also probable that the centrifugal machine may find use in the cheese factory in the manufacture of rich cheeses and it is likely that at a less speed than for cream raising it may be used to drain the whey from curd. It can certainly find profitable use in city supply. Milk unsold can be quickly and cheaply separated into cream for the making of butter, and thus souring and other waste prevented.

Further experimentation is, however, required in order that the possibilities of profit to be acquired through the use of this force may be demonstrated. What is its cleansing power on the milk? What the effect of working upon milk rendered more dense by the addition of sugar or salt? What is its effect on the fats, as influencing butter making and butter keeping? What change, if any, does it produce on the skim-milk? Can this force be use in cheese making for the separation of the curd as coagulated? Can adulteration be detected by its aid? And so we might continue, but until experiments are carefully made such conjecturing must belong to the region of fancy rather than to that of reality.

PROGRESS OF FORESTRY INVESTIGATION.

LOWVILLE, N. Y., *June* 10, 1881.

DEAR SIR: As you are about to terminate your official relation with the Department of Agriculture, I deem it proper to briefly summarize the measures that have reference to forestry, the subject that has been more immediately under my own charge under your general direction.

The annual and monthly reports of the department show that attention was being drawn to the subject of forest supplies, as they were every year becoming less, and thoughtful men were looking forward to a time, not distant, when scarcity and high prices must gradually become seriously felt, and were convinced that measures ought to be taken in some way to provide against needless waste while a portion of the native supplies still remain.

With the exception of applications for grants of land, for encouragement in tree planting, or experiments in acclimatization, nothing, however, had been proposed, and except certain reservations of live-oak and red cedar nothing had been done for the maintenance and reproduction of our forests. Some attempts had been made, from time to time, to extend protection to the timber on the public lands, but with very little success.

In 1873 the first act was passed by Congress granting portions of land to individuals for encouragement in planting, and this act has been twice amended, from time to time, as its defects became apparent. It has been in charge of the General Land Office, in the Department of the Interior, and the only instructions that have been issued are the rulings and decisions of the Department from time to time. The real and evident intentions of the act have, in many instances, been realized; but in many more the law has afforded only a pretext for occupation for merely speculative purposes.

In the winter of 1873–'74 a memorial from a committee of the "American Association for the Advancement of Science" was transmitted by the President to both houses of Congress, and in each it was referred to the Committee on Public Lands. A subcommittee, consisting of Mr. George B. Emerson, of Boston, and myself, attended on the part of the association, to support the measure as opportunities allowed. The House committee reported a bill for the appointment of a Commissioner of Forestry, with powers analogous to those of the Commissioner of Fisheries, with the view of making researches and reporting to Congress. This bill made some progress, but failed to pass, and the Forty-third Congress expired without further action.

Early in the Forty-fourth Congress the bill was again introduced in the House of Representatives, upon motion of Hon. Mark H. Dunnell, of Minnesota, who from the first has taken especial interest in this measure, and before its adjournment (August 15, 1876), a clause embracing the essential feature of the bill was, upon his amendment, inserted in an appropriation bill providing for the Department of Agriculture.

A few days after, I received from your predecessor, Hon. Frederick

Watts, a commission reciting the terms of the act as my instructions. They directed that inquiries should be prosecuted "with a view of ascertaining the annual amount of consumption, importation, and exportation of timber and other forest products; the probable supply for future wants, and the means best adapted for the preservation and restoration or planting of forests," and a report upon the same was to be made to the Commissioner of Agriculture, to be by him transmitted in a special report to Congress.

The Centennial Exhibition of 1876 was then in progress at Philadelphia, and I devoted the first two months after receiving my appointment, in a study of the forest products that were there displayed, and the winter following, in the public libraries, where the scanty literature upon this subject that the country then afforded could best be found. I may here remark that nothing has proved so great an obstacle in the study of this subject as the absence of books and periodicals especially devoted to its interests.

From the beginning I adopted the custom of making card lists of titles to separate works or to articles in periodicals and documents relating to forestry; but although I have several thousands of these, the greater number cannot be found in any library in the country, and I know only of their existence from their citation by authors, or their announcement in reviews. In fact, there is nothing more needed than a special library upon this subject for the use of the Department, and for the aid of those who may be following particular lines of investigation.

Early in 1877, I undertook a journey which led through most of the Western States and Territories extending westward to Utah, and from Lake Superior to the southern border of Kansas. While absent on this journey, I learned of your appointment as Commissioner of Agriculture, and from the earliest moment of acquaintance I have realized the interest that you have taken in forestry, and have felt your firm support.

Early in December, 1877, I submitted my first report, which, after due examination and approval, was transmitted to the President, and by him to Congress. An edition of 25,000 copies beyond the usual number was ordered, and the work has been widely distributed, and very generally approved, as shown by notices and reviews. I deem it, however, as due to the department, to notice here that a limitation to 650 pages, placed by the Committee upon Printing, rendered it necessary to abridge some portions that should have been given entire, and to omit other parts altogether. It was not, therefore, as printed, a compliance with the law under which it was ordered, and under this view of the case you very justly regarded the appointment as still pending, and a further investigation of the subject required.

Near the beginning of 1879, a second report, embracing many details not previously included, was sent in to Congress by the President, under a resolution of the House, but for reasons wholly foreign to the subject no action was taken during the session that ended on the 4th of March in that year. In fact, the chairman of the Committee on Agriculture, to which the report was referred, scarcely called the committee together during the session, and there was therefore no opportunity for its consideration.

Early in 1880, however, the report was again sent in, under a resolution of the House. It was at once ordered to be printed, and the subject of forestry, in connection with the report, was referred to the Committee on Agriculture. This committee, after a full hearing from yourself and from me, and upon an examination of the report in detail,

unanimously agreed to recommend the publication of 100,000 copies extra of this report, and of 50,000 copies extra of the first report. This resolution was referred to the House Committee on Printing, but lay as unfinished business upon their table when that Congress expired.

In the mean time the report was printed under the House resolution, and it being stereotyped (as is the first report), it is to be hoped that extra editions may in future be ordered. This report fully exhausts the subject of the exportation and importation of forest products, and in this covers the whole period of our government, from the organization in 1789, down to date.

Congress, in 1880, in appropriating means for the continuance of these researches, made the service of indefinite duration, to be prosecuted as a regular branch of inquiry until expressly terminated by law, thus placing it like other subjects of recognized and usual expense upon the list of items for which estimates are regularly made. Your administration will therefore stand upon the record as that when the first report upon forestry was made, and when the service was regularly begun.

Under this arrangement, I received a new commission, and was soon assigned an office in the department. A clerk was appointed to assist in these labors, and the facilities of the department in the way of printing and correspondence were made available. I had previously issued several thousand circulars upon several classes of subjects, and the information thus obtained had been embodied, so far as proper, in the reports that had been printed.

After opening the office in the department a series of circulars upon the subject of forest fires, and upon the extent of injuries from the dying off of the spruce timber of the Northeastern States were issued, and an extensive correspondence was instituted upon subjects relating to forestry.

In the summer of 1880 I made a journey through the New England States, chiefly in Maine, and visited with a guide the spruce forests that were suffering from disease with the view of learning by personal inquiry the extent of the injuries, and if possible to ascertain their cause. This journey was extended into the Province of New Brunswick and through the Province of Quebec on my return.

Later in the season I undertook, under your direction, a journey into the Western States and Territories, which amounted to nearly 8,000 miles in extent and led through fourteen of the States and three of the Territories. The object of these journeys was to ascertain by personal observation and local inquiry as much as possible upon the general subject of forestry, with the view of recommending such measures as might be deemed most effectual for promoting its interests.

On this, as on the former western journey, I had occasion to notice that the questions involved in forestry are steadily gaining in interest as they become better understood and felt, and I am confident that in the future they will acquire commanding importance among the questions before the country and under the charge of the Department of Agriculture.

A third report is nearly ready for presentation to Congress, and in this will be embodied such recommendations as to the future action of Congress upon the subject of forest conservation and management, and the various interests depending thereon, as the information before us will justify, and suggestions upon the prosecution of further measures for the advancement of our knowledge upon this subject.

From the beginning of these inquiries the suggestions of thoughtful and observing men have been deemed worthy of careful consideration,

and these with much unanimity agree in the belief that our main dependence for advancement must consist in carefully conducted experimental investigations, and a discriminating publication of the results that deserve notice.

We have still left in the Territories, and upon the Pacific coast, considerable forests upon the public lands that deserve prompt attention from the government, with the view of preventing needless waste, and securing a restoration by future growth; but with these exceptions it can scarcely be expected that either the States or the general government will for many years, if ever, undertake forest management for market supply, as is done in many countries in Europe. Since our lands are chiefly vested in private owners it is naturally to them we must look for planting with the view of supplying the industrial wants of the country, as they may hereafter arise. To render this most effectual the government should adopt measures for ascertaining whatever experience has taught or that experiment can ascertain, and it should make known to its citizens whatever is worth knowing in this line of inquiry, as well from the experience of other countries as from observations in our own.

With the view of personal inquiry with the officers of agricultural colleges, and in the hope of gaining from the observations of those who have undertaken tree planting in some portions of the New England States, I am at present engaged in a journey that will, when completed, lead through each of the New England States excepting Maine, and afford opportunities for the interchange of views with the officers of the agricultural colleges in each, upon the subject under investigation.

Respectfully, yours,

FRANKLIN B. HOUGH.

Hon. Wm. G. Le Duc,
Commissioner of Agriculture.

POTATO RAISING IN TENNESSEE.

BY C. W. CALLENDER, HENDERSONVILLE, TENN.

Under the system of labor existing in Tennessee prior to the war farmers were accustomed to devote all their tillable land to only one or two crops. Cotton and corn, or corn and tobacco, a little wheat, rye, or oats constituted the annual crop of most planters. Enough vegetables were raised to furnish an abundant supply for the family, but no one ever dreamed of raising them for shipment to market.

Under the present system of farming, Tennessee is rapidly adopting the policy of planting a variety of crops. While cotton, tobacco, and corn are still our main money crops, many of our most enterprising farmers are giving much attention to the raising and shipping of fruits and vegetables, especially of the earlier spring varieties, for Northern markets.

In this and adjoining counties, especial attention is devoted to the Irish potato crop. Heretofore we have been unable to raise our own seed potatoes; we were obliged, every spring, to purchase fresh supplies of Northern growth. This inability to save our own seed resulted from the fact that if we dug our crop as soon as it was matured the tubers were almost certain to rot during the long, hot, autumn months; if they escaped that danger, they shriveled and sprouted to such an extent, during the winter, that they were unfit for prolific seed in spring. If, on the other hand, we deferred the digging till the cool weather of fall, we found that the tubers had taken second growth during the warm autumnal rains. Crops from such seed were late and the yield unsatisfactory. The expense of annual purchase of seed, the difficulty of keeping the crop, acted to prevent any extensive cultivation of this important esculent.

An important change has been wrought in the cultivation of potatoes in our section within the last few years. We now buy no seed, but sell it in large quantities. Our potatoes, in the spring, are sound, firm, unshriveled and unsprouted. The home-raised produces marketable potatoes two or three weeks earlier than do the imported seed. The yield is not only earlier, but more abundant. The consequence is that "Tennessee second-crop" potatoes command in Nashville higher prices than do the best Northern article. The Tennessee seed is in demand, not only for home planting, but large amounts are beginning to be shipped to States both north and south of us. The method by which this great, and to us very profitable, change has been wrought is locally called "The second-crop method." It was introduced a few years since by some Northern immigrants, and has rapidly extended along the lines of railroad leading north. It is substantially as follows:

A piece of new ground is selected; those lands which were once bluegrass pastures, but which from unavoidable neglect during the war have grown up in thickets of blackberry vines and young trees, are usually

preferred, though any good fresh land will answer. This is cleared, well broken and harrowed, and laid off in checks about 30 inches each way. In each check are dropped two eyes; the aim being to get at least one healthy stock to each hill. The crop is planted from the 1st to the 20th of March, if possible. The seed is covered with hoes about 3 inches deep. As soon as the young shoots appear, two furrows with one-horse plow are thrown upon them, so as to cover them up and so protect them from late spring frosts. In a few days this covering is swept off by a drag or harrow. When the plants are from four to six inches high, they are plowed across the rows, throwing the soil to them. If the ground has been properly prepared no additional work will usually be needed.

As soon as the hills will average two good marketable potatoes (prices justifying), the crop is dug. The larger tubers are put in ventilated barrels and immediately shipped to Cincinnati, Saint Louis, Chicago, or some other point north.

The tubers too small for market are gathered as they are dug and protected from the sun. Some persons spread them upon barn floors, some pile them under shady trees, or, if they can do no better, in the open field; in either of the latter cases, carefully covering the heaps with vines or weeds to protect them from the hot sun, which would infallibly destroy the germinating power.

The first crop is usually dug early in June. The yield varies from sixty to one hundred and twenty bushels of marketable potatoes per acre. The price of our potatoes last year varied from $4.25 to $2.50 per barrel in Cincinnati, according to earliness and quality.

Second crop.—The second crop is usually more profitable than the first; it furnishes our winter supply, our next spring's seed, and a large surplus for sale. It is produced as follows:

In the begining of July the ground, usually the same upon which the first crop was raised, is prepared by deep plowing and thorough harrowing. It would be better to raise the second crop upon a different plat from that on which the first was planted. Two crops in one year must, of necessity, soon exhaust the richest soil; it would certainly seem to be more profitable for the farmer to raise his early crop for market upon his quick, fresh land, and plant his seed for second crop upon other land. It is asserted, however, by some that after land has been double-cropped in potatoes for even three or four years it will produce any other crop as well as if it had never been so tilled, but this assertion is open to much doubt.

After the soil is properly prepared, it is laid off in drills, with a one-horse plow, about 30 inches apart, in order that two furrows may properly clean out each middle. As the great difficulty with the second crop is to get a good stand, at least twice as much seed is dropped in the drills as is expected to come up. Much of it rots, or for other causes fails to grow. The potatoes, at this planting, are covered with *two furrows* with a one-horse plow to insure the requisite moisture for germination. As soon as they begin to sprout, which must be ascertained by digging into the ridges, the land is leveled by a harrow or, better still, by a drag, so that the plant may make rapid growth and so mature its tubers before frost. As soon as the weeds begin to appear between the ridges, the crop is plowed; another plowing when the plants are a few inches high is all the after cultivation needed.

As before stated, the chief difficulty in making a good second crop, is the obtaining of a good stand. The proper management of the seed has much to do in assuring success. Too much care cannot be exercised in protecting the seed from the blistering rays of the sun, at the time of

digging the first crop. If the second crop be planted on a bright, hot, sunny day, the covering plow should follow the seed dropper as closely as possible. After the seed has been duly seasoned in the shade, it is cut lengthwise, *i. e.*, from stem to blossom end; and all tubers too small to be cut in that manner must be "scalped," *i. e.*, a slice must be cut from the stem end. If this be omitted, such potatoes will not come up at all, or at least not in time to mature tubers before frost. In order to fairly test this fact, I planted two rows of Early Rose potatoes, seed uncut, about 1½ inches in diameter. Scarcely any of them came up, while the scalped seed on each side of them did as well as usual. I also selected twenty-three Beauty of Hebron, of same size as above, and planted them *uncut*, beside twenty-three of same size and variety which had been "scalped." I got seventeen good plants from the latter lot; but none of the former came up in time to make seed.

Seed for the second crop should not be allowed to heal over, as the seed for the spring crop, but should be planted *as soon as cut.* But one person of a number consulted got a stand from "healed-over" seed. Those who planted the seed as *soon as cut*, and covered immediately, in damp ground, with two furrows, succeeded best. Just before, or directly after a rain, if soil be in good working order, is the most favorable time for planting. Some crops utterly failed this year from being planted in a dry, hot soil; the seed all rotted.

Such, in short, is the amount of what we have so far learned about double cropping the potato. Time, patience, and experience are requisite to perfect the method. We have yet much to learn. Our section seems well suited to it. We have an average of 189 days between the killing frosts of spring and those of autumn. South of Tennessee the fall is too hot for double crops. North of us the fall frosts are too early.

The Early Rose is the only potato yet used in "second cropping," and some assert that no other variety will succeed. I am satisfied this idea is erroneous. I purchased my seed for first crop last year in Buffalo, N. Y., and at the same time some northern Peach Blows. A few of the latter, accidentally, got among the Early Rose, and when the first crop was dug I got Peach Blows of good marketable size. I shall try a few bushels of them this spring.

I may remark, in passing, that although I planted my northern seed a week or ten days *before* my neighbors planted Tennessee second crops, I was in market about ten days behind them.

In my report of test of seeds sent me last year by the department, I mentioned that I had succeeded in double cropping the Beauty of Hebron; I succeeded as well with them as with the Early Rose. In fact, I think, in suitable seasons, any variety may be as successfully second-cropped as the Early Rose.

I think seed of any kind raised here late in the fall will be superior to that maturing during our hot summers and early autumn months. Perhaps by this method we can prevent the deterioration of vegetables, so common in our climate; and again, as in the potato, a seed that will yield us earlier and better returns. I purpose trying the experiment with peas.

ERRATA TO REPORT OF ENTOMOLOGIST.

Page 236 l. 7, add Plate II, Fig. 3.
" 240 l. 15, add Plate II, Fig. 2, 2*a*.
" 249 l. 19, add Plate I.
" 275 l. 42, for Fig 2, read Fig. 1.
" 280 l. 19, for Plate XX, Fig. 4, read Plate XI, 7.
" 281 l. 30, for "one to that of the female," read "one to that of the male."
" 293 l. 29, for Plate XIV, read Plate XIII.
" 294 l. 34, for Plate XIII, read III.
" 296 l. 46, for "Fig. 1; natural size, Fig. 2," read "Fig. 2, natural size; Fig. 2*a*."
" 297 l. 37, for "Plate I, Fig. 3," read "Plate III, Fig. 2*b*."
" 372, explanation of Plate VIII, l. 3, for Fig. 3, read Fig. 2.
" " explanation of Plate X, for 1*c* read 1*e*, and vice versa.
" " explanation of Plate XI, l. 11, read "scale of female, enlarged; 4*b* scale of male."

Plate II. Letter this plate as follows: Lower left-hand figure (Chalcid) 1; upper right-hand figure (moth and larva) 2; segment of sugar-cane with pupa 2*a*; root of sugar-cane with beetle, 3.

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